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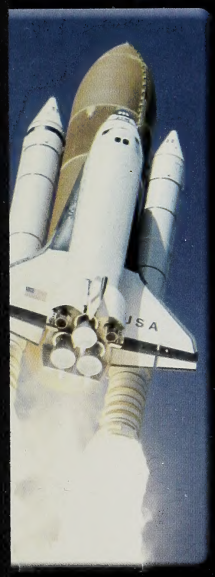

MODULE 2 • ENERGY TRANSFORMATIONS •

SCIENCE 24

MODULE 2 • ENERGY TRANSFORMATIONS

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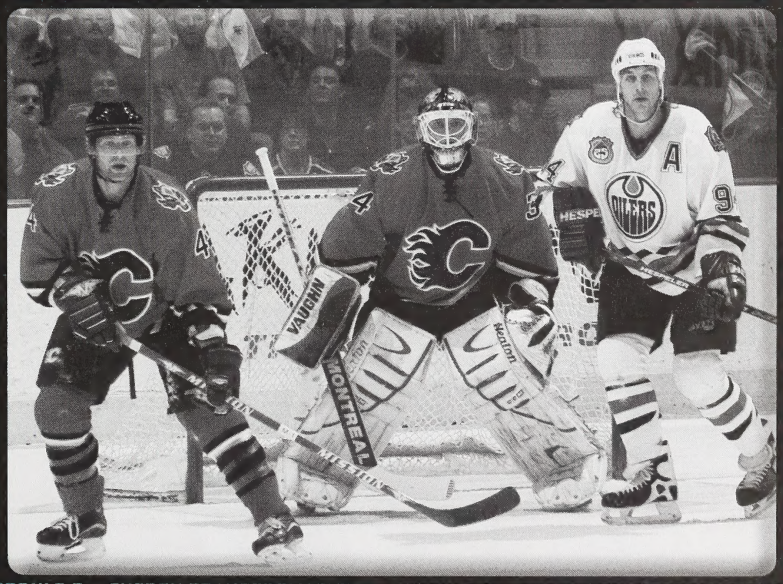

TRANSFORMATIONS ■ MODULE 2 ■ ENERGY TRANSFORMATIONS ■

Science 24
Module 2: Energy Transformations
Student Module Booklet
Learning Technologies Branch
ISBN 0-7741-2572-1

The Learning Technologies Branch acknowledges with appreciation the Alberta Distance Learning Centre and Pembina Hills Regional Division No. 7 for their review of this Student Module Booklet.

This document is intended for	
Students	✓
Teachers	✓
Administrators	
Home Instructors	
General Public	
Other	

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- Alberta Learning, **http://www.learning.gov.ab.ca**
- Learning Technologies Branch, **http://www.learning.gov.ab.ca/ltb**
- Learning Resources Centre, **http://www.lrc.learning.gov.ab.ca**

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Welcome to

SCIENCE 24

Module Two

Science 24 contains four modules.
You should work through the modules in order (from 1 to 4) because concepts and skills introduced in one module will be reinforced, extended, and applied in later modules.

Module 1 contains general information about the course, course components, resources, assessment and feedback, and visual cues. If you do not have access to Module 1, contact your teacher to obtain this important information.

MODULE 1
- MATTER AND CHEMICAL CHANGE -

MODULE 2
- ENERGY TRANSFORMATIONS -

MODULE 3
- DISEASE DEFENCE AND HUMAN HEALTH -

MODULE 4
- SAFETY IN TRANSPORTATION -

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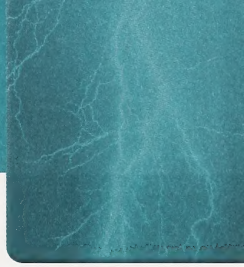

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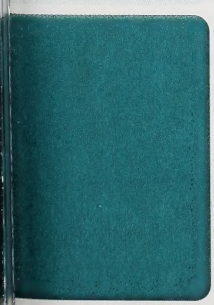
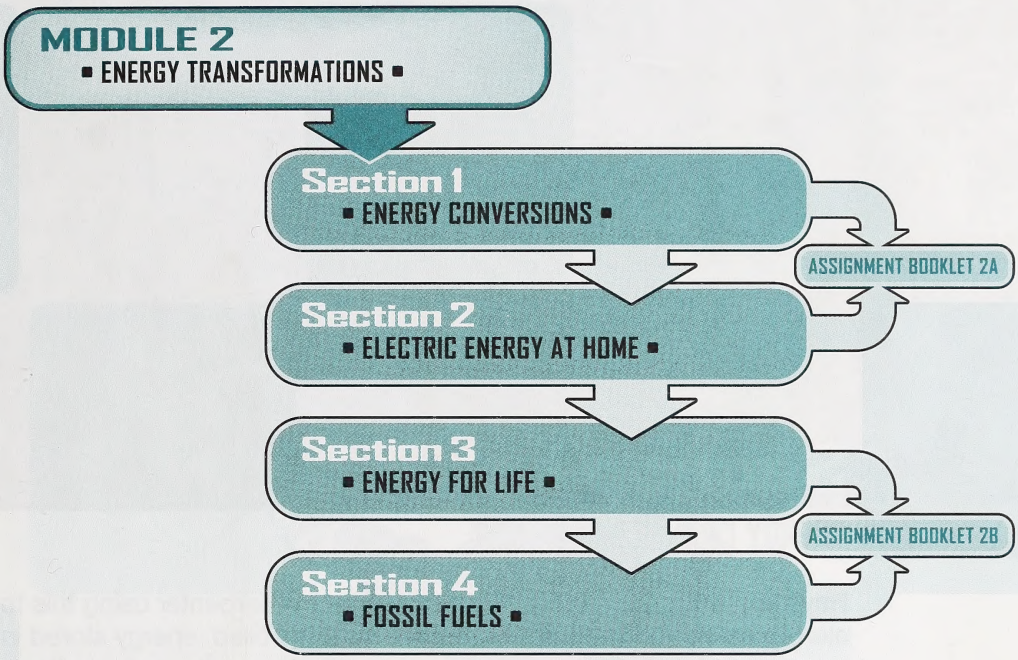


Module Overview

Jeremy and his friends enjoy snowboarding. They especially enjoy doing the halfpipe at the local ski hill. Going side to side, Jeremy and his friends appear to hang in mid-air while performing tricks. Skilled snowboarders, like Jeremy, can perform these tricks because of their ability to harness energy. As these athletes carry out their routines, gravitational energy stored at the beginning of their run is repeatedly transformed into the energy of motion and then back into gravitational energy.

The skill of these performers depend on co-ordination and split-second timing. Muscles must respond immediately, using the energy stored in their cells. This energy is transformed into movements that are critical for the successful completion of each trick.

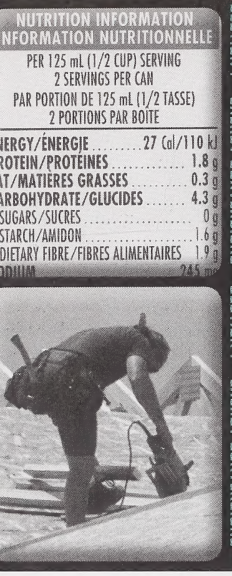
In this module you will explore how one form of energy is transformed into another—not only for the tasks people and machines perform, but also so that energy, such as electric energy, can be transported from where it is produced to where it is needed. You will also investigate how energy can be conserved and the importance of balancing your energy intake and energy requirements. You will then discover how fossil fuels are extracted and refined and how the combustion of fossil fuels has an impact on the environment.

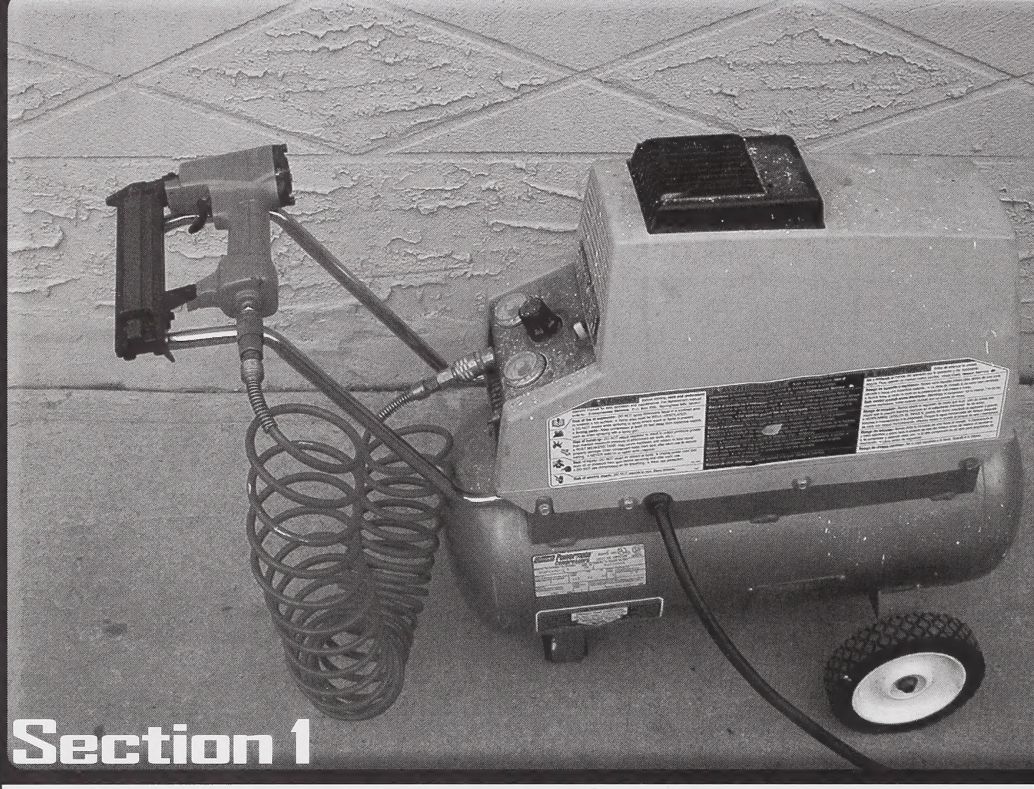


Assessment

This module, Energy Transformations, has four section assignments. The mark distribution is as follows:

Assignment Booklet 2A	
Section 1 Assignment	23 marks
Section 2 Assignment	29 marks
Assignment Booklet 2B	
Section 3 Assignment	25 marks
Section 4 Assignment	33 marks
Total	**110 marks**





Section 1

ENERGY CONVERSIONS

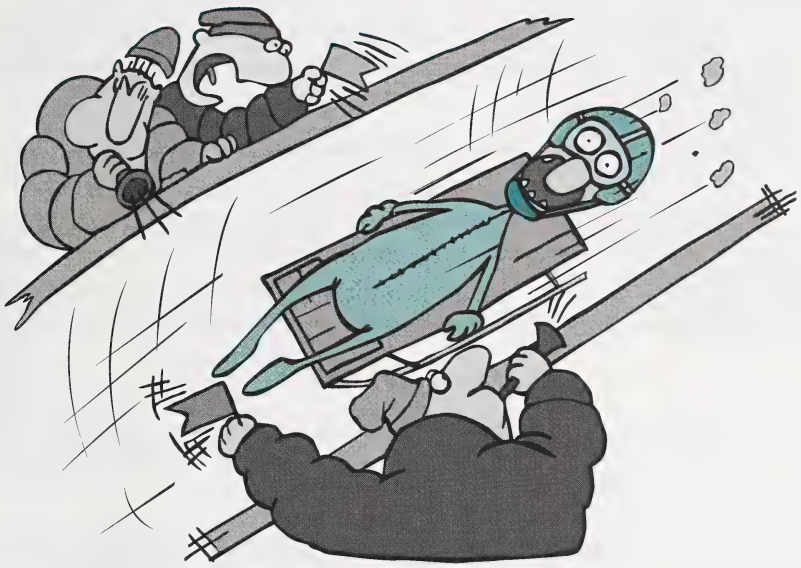
Have you ever operated a pneumatic nailer? A carpenter using this tool must be alert to safety at all times. When the trigger is pulled, energy stored in the compressed air is converted into energy that drives the nail into the wood. The air hose in the photograph is connected to an electric air compressor. The electricity that powers the compressor, in Alberta anyway, most likely came from a coal-fired power plant. The energy in the coal has been locked in that form for millions of years, originating from plants that depended on the energy from the Sun for their existence. So, you can say that using a pneumatic nailer today is harnessing the energy of the Sun that fell on Earth eons ago!

Society, today, is dependent on the harnessing of energy in a variety of forms. In this section you will explore the various forms of energy, how it changes from one form to another, and that energy is conserved.

Turn to pages 80 and 81 of the textbook. Read the introduction to "Chapter 5: Energy Conversions." After reading the introduction, read "Science Log." Think about the questions being asked. You will learn more about these questions in this section. You should also read over the points in "What You Will Learn," "Why It Is Important," and "Skills You Will Use" on page 81. These points provide a brief overview of what will be covered in this section.

Lesson 1

Energy



As a luge hurtles down the track, it can reach speeds of 100 km/h or more! A luge has no engine or visible means of propulsion. So what is making it move down the track? Where does its **energy** come from? In science, energy is the ability to do work.

energy: the ability to do work

At the top of the run, all the energy of the luge and the rider is called **potential energy**, or stored energy. As the luge speeds down the track, it converts gravitational potential energy into **kinetic energy**, the energy of motion.

potential energy: stored energy

kinetic energy: energy of motion

In this lesson you will explore the relationship between potential energy and kinetic energy.

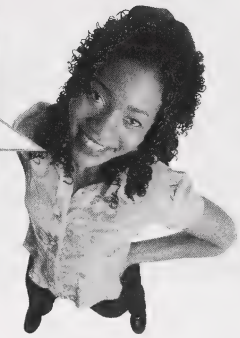
Starting Point
Activity

Do Pendulums Return to the Sender?

Read the entire activity on page 81 of the textbook.

Complete steps 2 to 4 of "What to Do." Follow the instructions carefully, and **pay special attention to the safety precautions mentioned**.

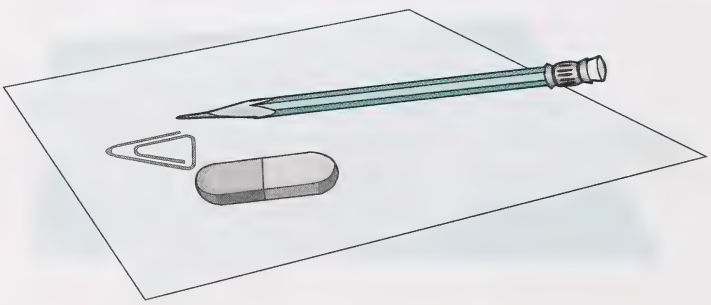
If you don't have a 500-g mass, you can substitute any object that has an approximate mass of 500 g. Some suggestions include a 500-mL soft drink or a block of wood.



1. What did you observe?
2. At what point(s) does the pendulum have its greatest potential energy?
3. At what point(s) does the pendulum have its greatest kinetic energy?
4. a. What is the approximate height the mass returns to?

   b. Why does the activity suggest you position yourself so that the back of your head is against the wall?

CHECK Check your answers on page 114 of the Appendix.



Turn to page 82 of the textbook. Read the introductory paragraphs of "Energy." Then continue on page 82 by reading "Using Energy to Do Work."

5. Classify each of the following as examples of potential energy or kinetic energy.

   a. the energy of Alexander and his toboggan sliding down a hill just as he reaches the bottom of the hill

   b. the chemical energy stored in glucose for your muscles

   c. the energy in a lump of sugar

   d. the energy of Tiger Woods's golf swing

CHECK Check your answers on page 114 of the Appendix.

In the next activity you will design a mousetrap car that converts the potential energy of the loaded spring of a mousetrap into energy that propels the car forward.

Before you begin your investigation, you may want to view what other students have done. Insert the *Science 24 Multimedia* CD into your computer, and view the segment "Mousetrap-Powered Cars."

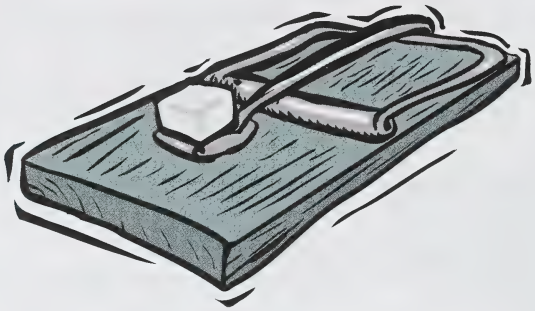
Also, if you have access to the Internet, there are numerous websites that feature hints, suggestions, plans and photographs of mousetrap cars, and records to challenge you. Simply enter the words *mousetrap cars* into any of the Internet's search engines. Here is one such website:

http://cpphysics.homestead.com/mousetrap3.html

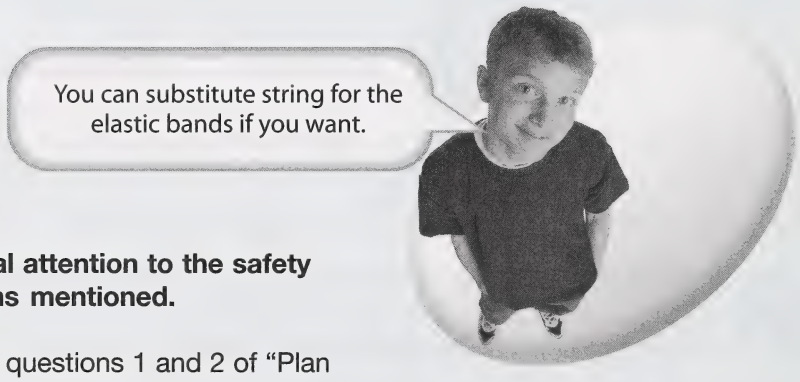
Investigation

5-A: Power a Car with a Mousetrap

Read the entire investigation on page 83 of the textbook.



Follow the instructions in "Design Criteria" and "Plan and Construct" carefully. If you are working at home, use the "Mousetrap-Powered Cars" segment on the *Science 24 Multimedia* CD or the Internet to confirm your design in place of a teacher.



Pay special attention to the safety precautions mentioned.

6. Answer questions 1 and 2 of "Plan and Construct."

CHECK Check your answers on page 115 of the Appendix.

You have now completed the concepts for this lesson.
Do the following questions to review what you studied.

7. Answer questions 1 and 2 of "Check Your Understanding" on page 83 of the textbook.

CHECK Check your answers on pages 115 and 116 of the Appendix.

Go to ... Go to pages 1 and 2 of Assignment Booklet 2A and answer questions 1 to 4.

Lesson 2

Many Forms of Energy

Skydivers in free fall lose gravitational potential energy as they descend. In turn, skydivers pick up kinetic energy as they accelerate. In Lesson 1 you explored potential energy (stored energy) and kinetic energy (the energy of motion). In this lesson you will study the many forms of potential energy and kinetic energy.

To review potential and kinetic energy, study the following example.

Example

A bouncing ball gains and loses potential and kinetic energy. Answer the following for a ball bouncing straight up and down.

(a) When is the gravitational potential energy of the ball a maximum? What is its kinetic energy at that point?

(b) When is the kinetic energy of the ball a maximum? What is its gravitational potential energy at that point?

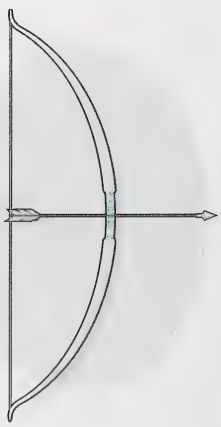
Solution

(a) The gravitational potential energy of the ball is a maximum at the top of its rise. The ball stops momentarily at this point. The kinetic energy of the ball is zero at this point.

(b) The kinetic energy of the ball is a maximum when it strikes the ground. Its speed is greatest at this point. The gravitational potential energy of the ball at this point is zero.

Now, it's time to check your understanding.

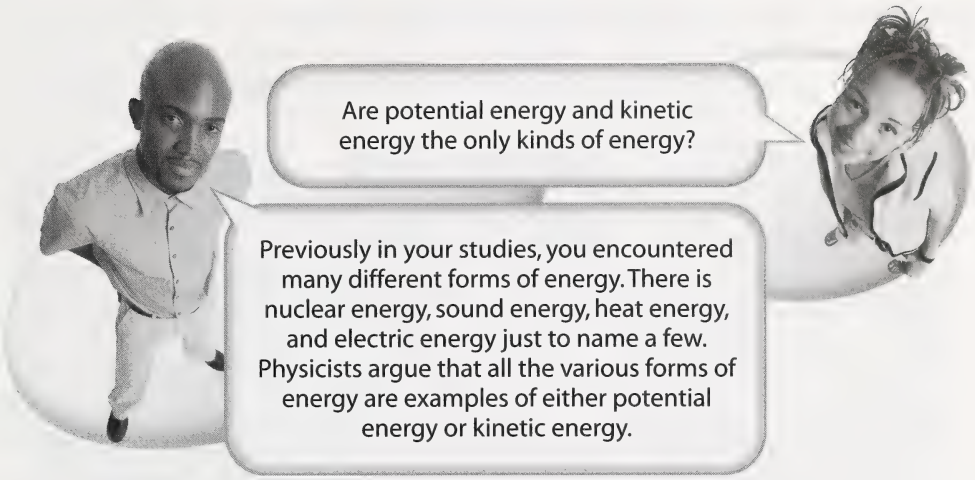
1. Study the graphic of a bow and arrow.



   a. When is the potential energy of the bow a maximum? What is its kinetic energy at this point?

   b. When is the kinetic energy of the arrow a maximum? What is the potential energy of the bow at this point?

Check your answers on page 116 of the Appendix.


Are potential energy and kinetic energy the only kinds of energy?
Previously in your studies, you encountered many different forms of energy. There is nuclear energy, sound energy, heat energy, and electric energy just to name a few. Physicists argue that all the various forms of energy are examples of either potential energy or kinetic energy.

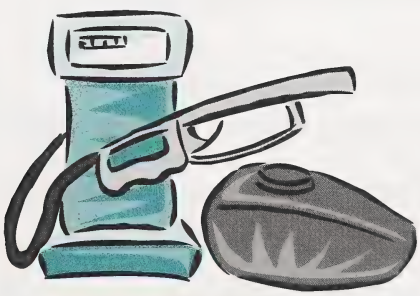
Some forms of potential energy are as follows:

- **nuclear energy:** This is energy stored in atoms. It's the energy binding protons and neutrons together in the nucleus. It's the energy that is released in the interior of Earth. Without the release of nuclear energy, the Earth's core would have cooled long ago.

- **gravitational potential energy:** This form depends on the position of objects. For example, a car at the top of a ramp has gravitational potential energy.

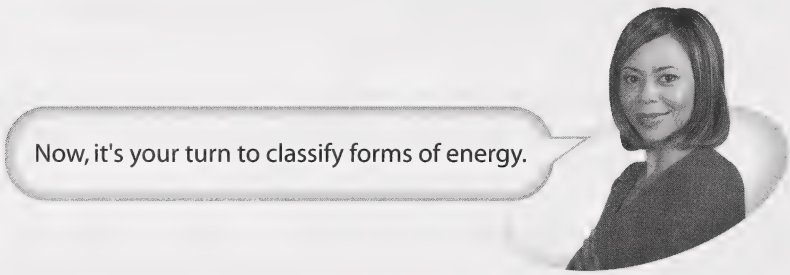
- **mechanical potential energy:** This is energy stored in an object as a result of work being done. For example, the compression of a spring, a stretched elastic band, and a drawn bow each possess mechanical potential energy.

- **chemical potential energy:** This is energy stored in compounds. Oil, natural gas, and coal are important chemical potential energy reservoirs.



Some forms of kinetic energy are as follows:

- **thermal energy (heat):** This form involves the vibration of atoms or molecules within a substance. The more energetic the motion, the hotter the substance.
- **mechanical kinetic energy:** This form involves the motion of objects (e.g., a ball in flight and moving parts in a machine).
- **electric energy:** This form involves the movement of electrons along a conductor.
- **electromagnetic or radiant energy:** This form includes visible light, infrared light, ultraviolet light, radio waves, and X rays. This form of energy travels in waves and particles and can travel through a vacuum. The Sun is the primary source of radiant energy that most life on Earth depends on.
- **sound energy:** This form travels though matter. Sound is transmitted by the compression and separation of particles in the medium through which the sound waves travel.



2. What form of energy is each of the following?

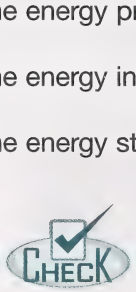
   a. sunlight

   b. the energy of a rotating wheel

   c. the energy produced by a speaker

   d. the energy in a glass of hot chocolate

   e. the energy stored in a woodpile



Check your answers on page 116 of the Appendix.

Turn to page 84 of the textbook and read "Many Forms of Energy." Then read all the information provided in Figure 5.4 on pages 84 and 85. As you read the information, think about the forms of energy and sources of energy.

3. Name two sources of energy discussed on pages 84 and 85 of the textbook.

4. Answer questions 1, 2, and 3 of "Check Your Understanding" on page 85 of the textbook.

CHECK Check your answers on pages 116 and 117 of the Appendix.

Go to ... Go to page 2 of Assignment Booklet 2A and answer questions 5 to 7.

Lesson 3

Understanding Energy Conversion

converter: a system where energy is changed from one form to another

input energy: energy that enters a system

output energy: energy that leaves a system

If you are a racing fan, you probably know that Canada's Paul Tracy won the Vanderbilt Cup in 2003. The Vanderbilt Cup is given to the CART Champ Car World Series champion each year. Not only do you have to be a very skilled race car driver to win the Vanderbilt Cup, you have to have a very fast and competent pit crew and, most importantly, a finely tuned race car.

PAUL STRAK

Paul Tracy's race car, in fact any race car, is an example of a finely tuned energy **converter**. The potential chemical energy of the fuel is the **input energy**, and the mechanical kinetic energy of the car as it speeds down the track is the **output energy**. Input energy, the converter, and output energy are the three components of an energy conversion.

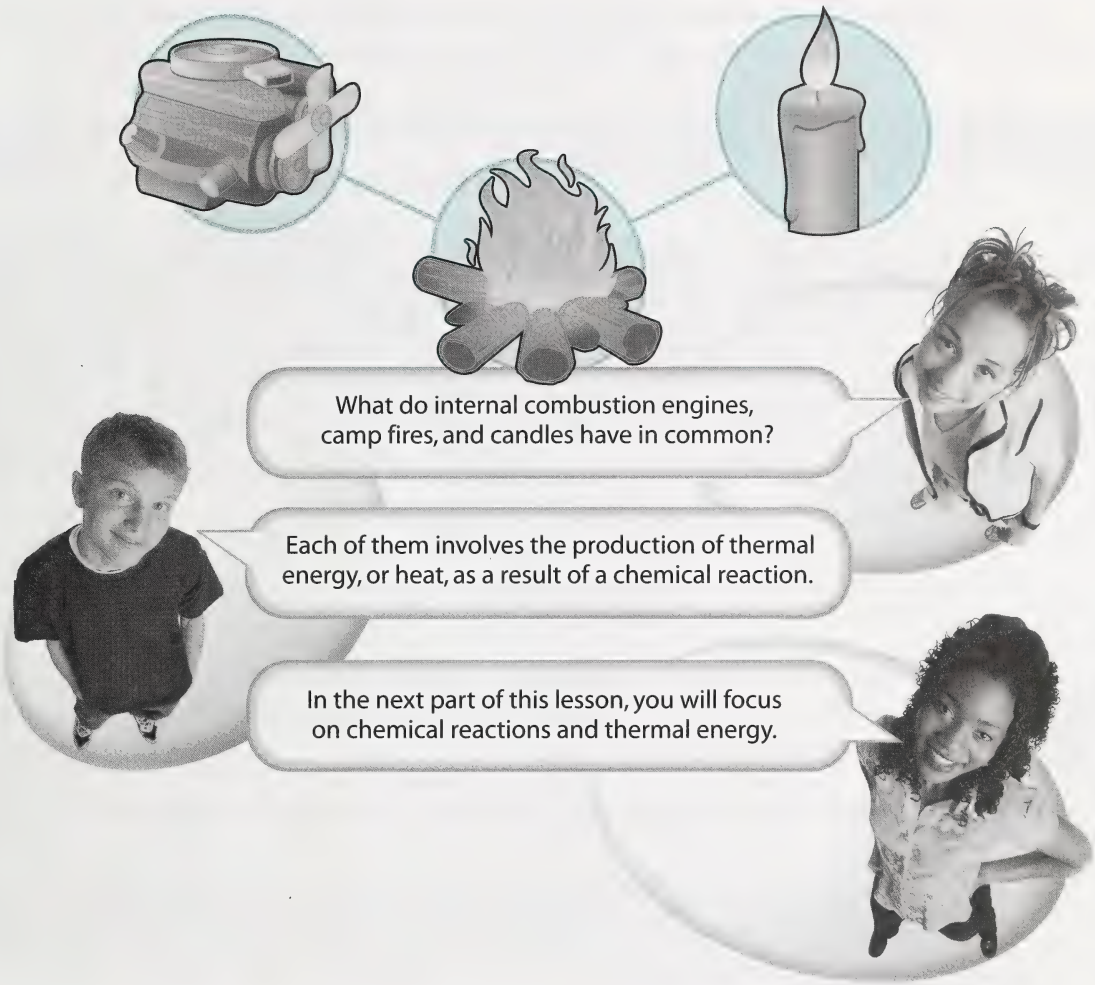
Turn to page 86 of the textbook and read the information presented in "Understanding Energy Conversion."

1. What are the input energy, the converter, and the output energy of a flashlight?

2. Answer the question posed in "Reading Check" on page 86 of the textbook.

3. In the photograph of Paul Tracy, identify the three components of energy conversion involved in raising the Vanderbilt Cup over his head.

Check your answers on page 117 of the Appendix.


What do internal combustion engines, camp fires, and candles have in common?
Each of them involves the production of thermal energy, or heat, as a result of a chemical reaction.
In the next part of this lesson, you will focus on chemical reactions and thermal energy.

Turn to page 87 of the textbook and read "Chemical Conversions."

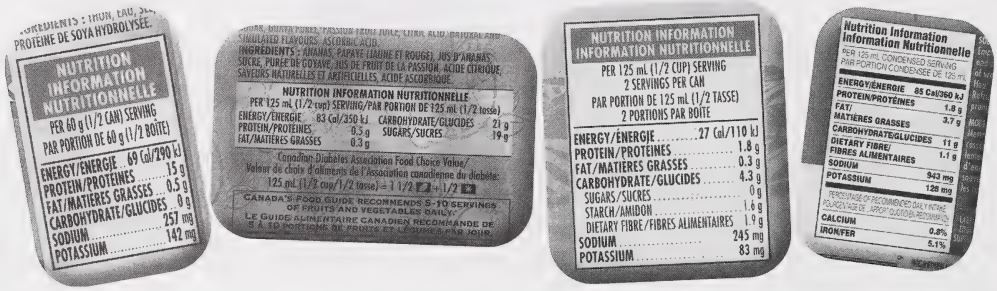
4. When you exercise, which two types of energy is potential energy from food converted into?

5. Which type of energy is contained in a commercial hot pack or cold pack?

6. What energy conversions occur when you kick a ball? Use the terms *potential energy*, *kinetic energy*, and *thermal energy*.

Check your answers on page 117 of the Appendix.

The food you eat provides the energy to keep you active and warm. Two units that describe the energy stored in food are the Calorie or kilocalorie (Cal or kcal) and the kilojoule (kJ). The food energy in an average serving is normally part of the nutrition information found on the labels of products. For example, check the energy content in these labels.

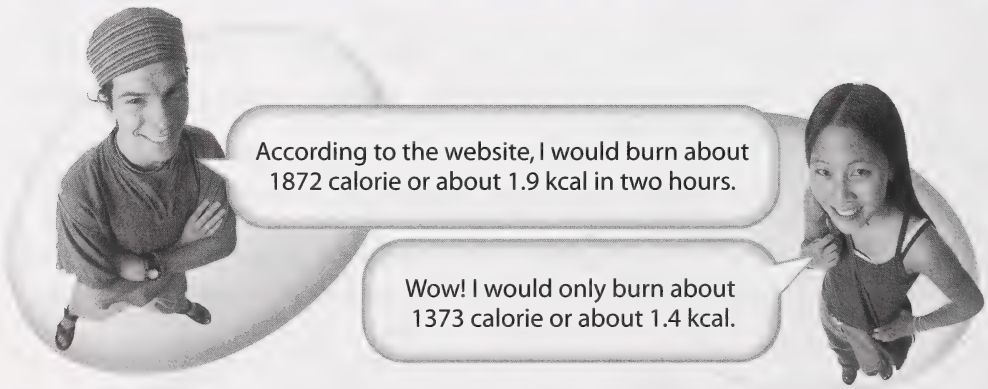

NUTRITION INFORMATION NUTRITIONNELLE
PER 60 g (1/2 CAN) SERVING
PAR PORTION DE 60 g (1/2 BOITE)
ENERGY/ENERGIE 69 Cal/290 kJ
PROTEIN/PROTEINES 15 g
FAT/MATIERES GRASSES 0.5 g
CARBOHYDRATE/GLUCIDES 9 g
SODIUM 257 mg
POTASSIUM 142 mg
NUTRITION INFORMATION NUTRITIONNELLE
PER 125 mL (1/2 cup) SERVING/PAR PORTION DE 125 mL (1/2 tasse)
ENERGY/ENERGIE 83 Cal/350 kJ
PROTEIN/PROTEINES 0.5 g
FAT/MATIERES GRASSES 0.3 g
CARBOHYDRATE/GLUCIDES 21 g
SUGARS/SUCRES 19 g
Canadian Diabetes Association Food Choice Value/
Valeur de choix d'aliments de l'Association canadienne du diabète:
125 mL (1/2 cup/1/2 tasse) = 1 1/2
CANADA'S FOOD GUIDE RECOMMENDS 5-10 SERVINGS OF FRUITS AND VEGETABLES DAILY
LE GUIDE ALIMENTAIRE CANADIEN RECOMMANDE DE 5 À 10 PORTIONS DE FRUITS ET LÉGUMES PAR JOUR
NUTRITION INFORMATION INFORMATION NUTRITIONNELLE
PER 125 mL (1/2 CUP) SERVING
2 SERVINGS PER CAN
PAR PORTION DE 125 mL (1/2 TASSE)
2 PORTIONS PAR BOITE
ENERGY/ENERGIE 27 Cal/110 kJ
PROTEIN/PROTEINES 1.8 g
FAT/MATIERES GRASSES 0.3 g
CARBOHYDRATE/GLUCIDES 4.3 g
SUGARS/SUCRES 0 g
STARCH/AMIDON 1.6 g
DIETARY FIBRE/FIBRES ALIMENTAIRES 1.9 g
SODIUM 245 mg
POTASSIUM 83 mg
Nutrition Information
Information Nutritionnelle
PER 125 mL CONDENSED SERVING
PAR PORTION CONDENSEE DE 125 mL
ENERGY/ENERGIE 85 Cal/360 kJ
PROTEIN/PROTÉINES 1.8 g
FAT/ MATIÈRES GRASSES 3.7 g
CARBOHYDRATE/GLUCIDES 11 g
DIETARY FIBRE/ FIBRES ALIMENTAIRES 1.1 g
SODIUM 943 mg
POTASSIUM 120 mg
CALCIUM 0.8%
IRON/FER 5.1%

The average adult requires between 1500 kcal and 2000 kcal per day. But did you know that these requirements may be much more for athletes and people involved in manual labour?

If you have access to the Internet, research how many kilocalories you would require for two hours of cross-country skiing. Here is one possible site you may wish to explore:

http://score.kings.k12.ca.us/lessons/calories/calorieburn.html

Note: This site uses the term *calorie*. The calories calculated below are based on a 150-pound male and a 110-pound female. One kcal or Calorie is equal to 1000 calories.


According to the website, I would burn about 1872 calorie or about 1.9 kcal in two hours.
Wow! I would only burn about 1373 calorie or about 1.4 kcal.

You know that some chemical reactions produce heat. Does this mean that all chemical reactions produce heat? To find out, conduct the following investigation.

Investigation

5-B: Chemical Reactions: Generating or Absorbing Heat?

Read the entire investigation on pages 88 and 89 of the textbook.

7. Answer questions 1 and 2 of "Prediction" on page 88.

Check your answers on page 117 of the Appendix.

Part 1: Citric Acid and Baking Soda

Complete Part 1 of the investigation on page 88 of the textbook. **Pay special attention to the safety precautions mentioned.**

If you are working at home, insert the *Science 24 Multimedia* CD into your computer. View the citric acid and baking soda demonstration in the "Chemical Reactions: Generating or Absorbing Heat?" segment.

8. Set up a chart similar to the following, and record your observations.

	Before Adding Baking Soda	After Adding Baking Soda
Mass of Cup and Acid		N/A
Mass of Baking Soda		N/A
Total Mass		
Temperature		

Check your answer on page 118 of the Appendix.

Part 2: Hydrochloric Acid and Magnesium Teacher Demonstration

Now, complete Part 2 of the investigation on pages 88 and 89 of the textbook. Because of the danger, you will not do the actual procedure. Instead, read through the description of the teacher demonstration. Then insert the *Science 24 Multimedia* CD into your computer. View the hydrochloric acid and magnesium demonstration in the "Chemical Reactions: Generating or Absorbing Heat?" segment.

9. Set up a chart similar to the following, and record your observations.

	Before Adding Magnesium	After Adding Magnesium
Mass of Cup and Acid		N/A
Mass of Magnesium		N/A
Total Mass		
Temperature		

10. Answer the following on page 89 of the textbook.

    a. questions 1 to 4 of "Analyze"

    b. question 5 of "Conclude and Apply"

CHECK Check your answers on pages 118 and 119 of the Appendix.

In the next investigation you will analyze a series of energy conversions.

Investigation

5-C: Energy Conversions Are Hard to Escape

Turn to pages 90 and 91 of the textbook and read through the entire investigation.

11. Follow the instructions given in "What to Do" to complete the following table.

The Converter	Input Energy	Output Energy	Is Thermal Energy Given Off?
flashlight bulb	*chemical energy (battery)*	*light energy (bulb)*	*yes*
snowblower engine			
person paddling			
drill press			
rocket			
person trampolining			
person eating			

12. Answer questions 1 and 2 of "Analyze."

Check your answers on pages 119 and 120 of the Appendix.

The previous investigations were conducted in a controlled environment. But uncontrolled chemical reactions can release explosive levels of energy that result in severe property and personal damage.

On December 6, 1917, a French vessel named *Mont-Blanc* collided with the *Imo*, a Belgian relief ship, in Halifax harbour. The *Mont-Blanc* was loaded with over 2.6 million kilograms of high explosives, including TNT and picric acid. The resulting explosion, the largest human-made explosion up to that time, levelled two square kilometres of Halifax and Dartmouth.

NATIONAL ARCHIVES OF CANADA/C-019945

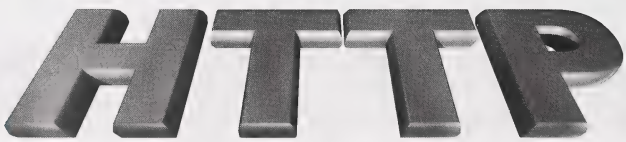
Over 2000 people lost their lives and close to 9000 people were injured in the Halifax explosion.

13. Outline the energy conversions that occurred when the *Mont-Blanc* exploded.

Check your answer on page 120 of the Appendix.

You can find out more about this horrendous Canadian tragedy at the following website:

http://www.cbc.ca/halifaxexplosion



From your work in this lesson, you discovered that thermal energy is a by-product of most activities. Did you know that a physicist by the name of James Joule demonstrated the equivalence of mechanical work and heat? He observed, for example, that the temperature of the water at the base of a waterfall is higher than the temperature of the water at the top of the waterfall. He also experimented with heat produced by electricity passing through a resistance. As a matter of fact, his name is used for a unit of energy—the joule.

James Joule (1818–1889)

If you have access to the Internet, you can find out more about James Joule at the following site:

http://scienceworld.wolfram.com/biography/Joule.html

Turn to page 91 of the textbook and read "When Is Thermal Energy Wasted?"

You have now completed the concepts for this lesson. Review what you studied by answering the following questions.

14. Answer questions 1, 2, and 3 of "Check Your Understanding" on page 91 of the textbook.

CHECK Check your answers on page 120 of the Appendix.

Go to ... Go to pages 2 and 3 of Assignment Booklet 2A and answer questions 8 to 12.

Lesson 4

Conservation of Energy

One of the more spectacular sights in the night sky is a fireball. A fireball is a large, bright meteor—occasionally bright enough to be seen in full daylight. Some people claim they have even heard fireballs hiss! Most meteors that venture near Earth are small dust particles that burn up through friction with the atmosphere well before they reach Earth's surface. The kinetic energy of the meteor is converted into light and heat energy. But how does this output energy compare to input energy?

In this lesson you will discover the relationship between input energy and output energy.

Turn to page 92 of the textbook. Read the discussion in "Conservation of Energy."

1. What is the input energy of a hair dryer?

2. What forms does the output energy of a hair dryer take?

3. What does the Law of Conservation of Energy tell you about the relationship between the input energy and output energy of a blow dryer?

Check your answers on page 120 of the Appendix.

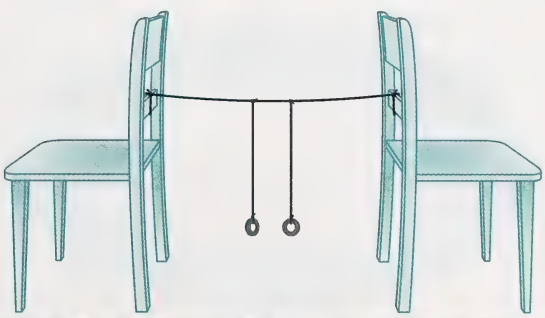
How can you demonstrate the Law of Conservation of Energy?

Find Out Activity

Do Swinging Pendulums Demonstrate the Law of Conservation of Energy?

Turn to page 93 of the textbook and read the entire activity.

Follow the instructions outlined in "What to Do." If you are doing this activity at home, you can tie the cord to the backs or two chairs instead of using stands and clamps. Pull the chairs far enough apart to tighten the cord between them; but do not pull the cord too tight. There should be a sag of about 3 cm after the two pendulums are attached. If you do not have washers for the pendulums, you can tape larger coins, like loonies or toonies, to the ends of the strings.



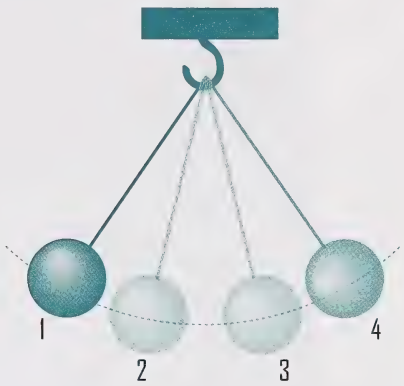
4. Answer questions 1 to 5 of "What Did You Find Out?"

Check your answers on page 121 of the Appendix.

You should now be able describe and give examples of the Law of Conservation of Energy. To see how this law applies to the energy of a single pendulum, go to the following site:

http://www.physicsclassroom.com/mmedia/energy/pe.html

At this site you can observe the changing kinetic and potential energies of a pendulum.



You have just completed the concepts for this lesson. Do the following question to review what you covered.

5. Answer question 2 of "Check Your Understanding" on page 93 of the textbook.

Check your answer on page 121 of the Appendix.

Go to page 4 of Assignment Booklet 2A and answer questions 13 and 14.

Lesson 5

Energy Conversion Systems

If you have driven or been a passenger in stop-and-go traffic and on the highway, you may have noticed how stop-and-go traffic affects fuel economy. Braking converts kinetic energy into heat. Touching the disc brakes of a vehicle with your fingers immediately after driving in stop-and-go traffic could result in a severe burn. Is it possible to harness some of the energy that goes to waste in braking to accelerate the vehicle after it has stopped? This issue has been partially addressed in the designs of hybrid cars.

In this lesson you will explore how waste heat affects the efficiencies of machines. You will also see how this waste heat is factored into the Law of Conservation of Energy, which you investigated in Lesson 4.

Turn to page 94 of the textbook. Read the information in "Energy Conversion Systems."

1. Write the statement of the Law of Conservation of Energy that includes the waste energy produced by machines.

2. Name the kinds of waste energy produced by a gasoline lawn mower.

Check your answers on page 121 of the Appendix.

If you have access to the Internet, complete "Internet Connect" on page 94 of the textbook. This activity will introduce you to some hybrid cars.

Investigation

5-D: Input and Output Energy

Turn to page 95 of the textbook and read through the entire investigation.

Complete steps 1 to 5 of "Plan and Construct." **Pay special attention to the safety precautions mentioned.** If you are working at home, have an adult evaluate your plan before you proceed with step 5.

3. Answer questions 1 to 4 of "Evaluate."

Check your answers on pages 121 and 122 of the Appendix.

If you have access to the Internet, you can study a more elaborate plan of a wind turbine. This plan can be found at the following website:

http://www.re-energy.ca/t_windenergy.shtml

You have now completed the concepts for this lesson.
Do the following question to review what you covered.

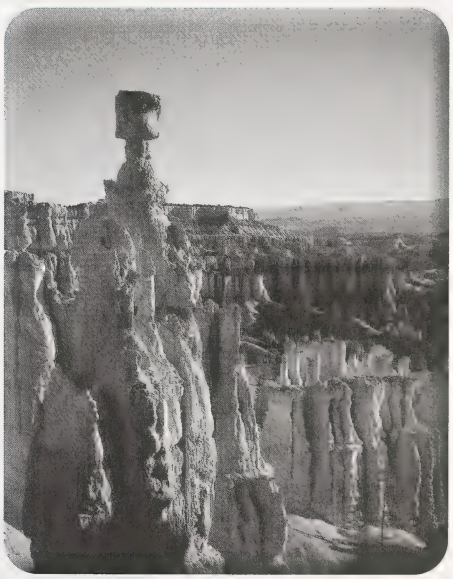
4. Answer question 2 of "Check Your Understanding" on page 95 of the textbook.

Check your answer on page 122 of the Appendix.

Go to page 4 of Assignment Booklet 2A and answer questions 15 and 16.

Section 1 Review

In this section you explored energy conversions. You examined various forms of energy and discovered that they all can be categorized as either potential energy or kinetic energy. You also investigated chemical reactions that release or absorb energy. You then studied the components of energy conversion, the Law of Conservation of Energy, and how waste energy is an unavoidable component of the output energy of machines.



Balancing rocks are a fascinating feature of water and wind erosion in the badlands of Alberta and in most deserts around the world. What form of energy does the rock in this photograph possess? Into what form would this energy be converted into if it were to fall?

You have now completed the concepts for this section. To review what you studied, insert the *Science.Connect 2 Student Multimedia* CD into your computer. Launch the "Energy Transformations" applet, and answer the questions that follow.

1. a. What are two examples of potential energy given in the introduction?

   b. How can the potential energy in the two examples be transformed into kinetic energy?

   c. Which two types of energy is the kinetic energy of a ball transformed into when it is caught in a baseball mitt? (Part 2)

   d. When the apple is halfway between the starting point in the tree and the ground, what is the relation between the amount of potential energy and the kinetic energy the apple has? (Part 3)

   e. What happens to the total energy as the apple falls (Part 3)?

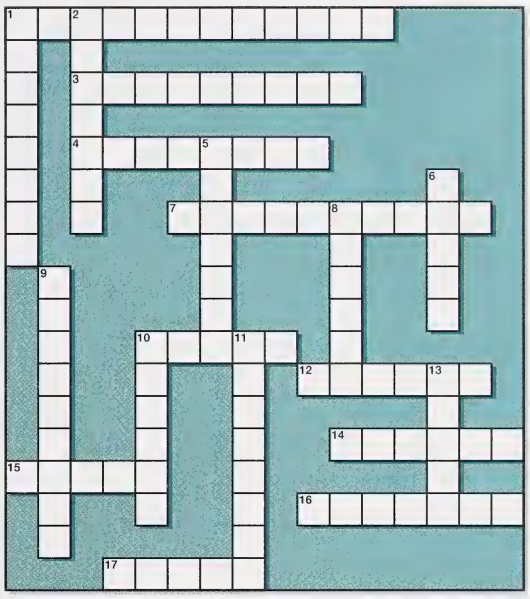
   f. What is the source energy for many energy transformations (Part 4)?

   g. Cellular respiration transforms _____ energy into _____ energy (Part 4).

   h. After being kicked, why does the soccer ball finally stop?

   i. The process of photosynthesis transforms solar energy into which type of energy?

2. Complete the following puzzle.



Across

1. a term describing the equality of input energy and output energy in an energy conversion
3. a system where energy is transformed
4. the input energy of a blow dryer
7. the source of energy for a hot spring
10. radiant energy that comes from the Sun
12. a type of car that utilizes a combination of sources of energy
14. energy that leaves an energy conversion system
15. a form of energy that can travel through a vacuum
16. the energy of motion
17. a form of energy transmitted through substances by waves

Down

1. a form of energy stored in your muscles
2. a form of energy stored in the nucleus of atoms
5. another name for heat energy
6. a term for the unwanted energy in an energy conversion
8. the ability to do work
9. stored energy
10. a necessary part of any experiment
11. Energy was _____ during the citric acid and baking soda experiment.
13. energy that enters an energy conversion system

3. Answer the following "Chapter 5 Review" questions on pages 96 and 97 of the textbook.

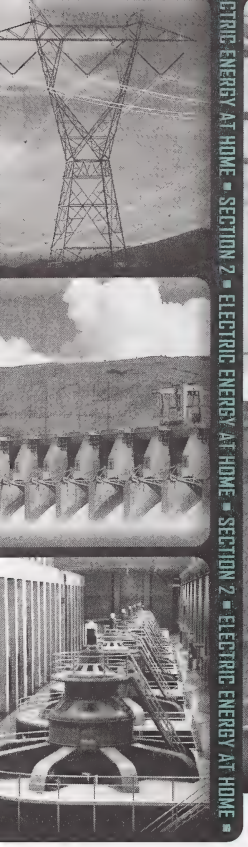
   a. questions 2 and 3 of "Understanding Key Ideas"

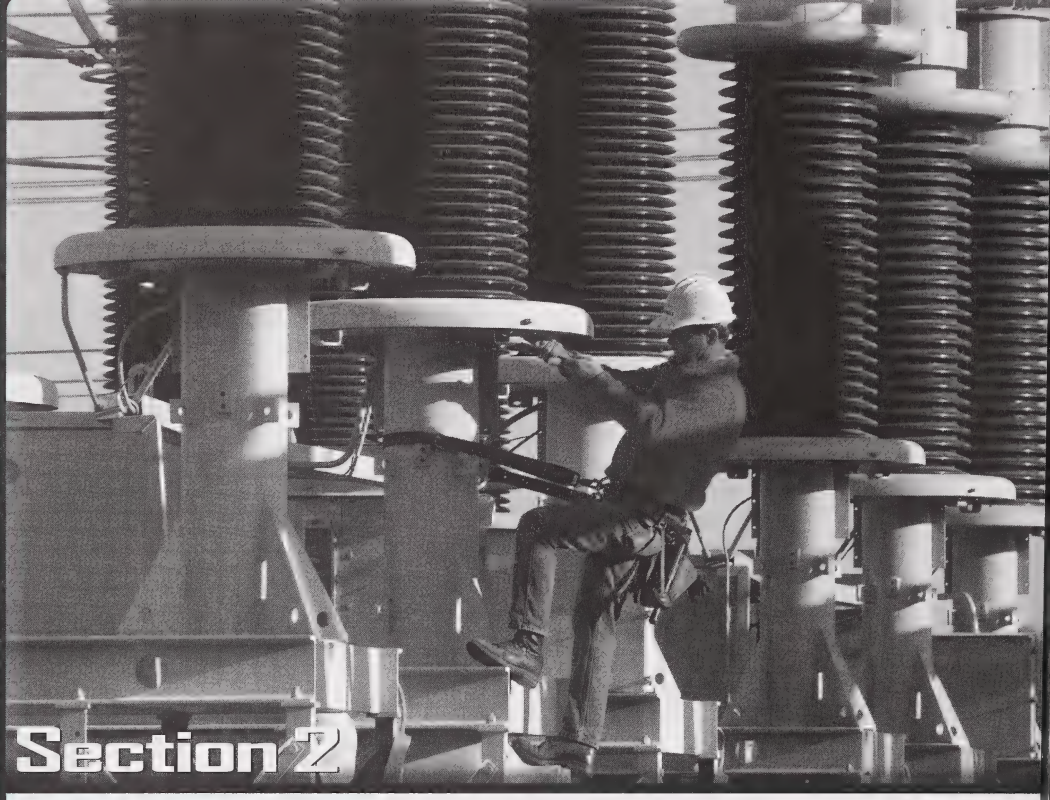
   b. questions 5, 6, and 7 of "Developing Skills"

   c. question 8 of "Problem Solving/Applying"

   d. question 12 of "Critical Thinking"

Check your answers on pages 122 to 124 of the Appendix.



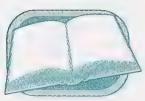


Section 2

ELECTRIC ENERGY AT HOME

Electricity is vital to a modern technological economy. Look around you. Can you imagine what life would be like without electricity? In winter your furnace would not operate. In summer you would not have refrigerators or freezers to keep food fresh. There would be no computers, radios, or televisions. You would have to do your laundry by hand. You wouldn't have electric lights in your home, let alone on the streets. These are just a few examples of the daily conveniences you would have to do without!

In this section you will explore how electricity can be generated and transmitted, how to measure the energy you use, and what steps you can take to conserve energy.



Turn to pages 98 and 99 of the textbook and read the introduction to "Chapter 6: Electric Energy at Home." Pay particular attention to the points in "What You Will Learn," "Why It Is Important," and "Skills You Will Use," on page 99. These provide a quick overview of what you will cover in this section.

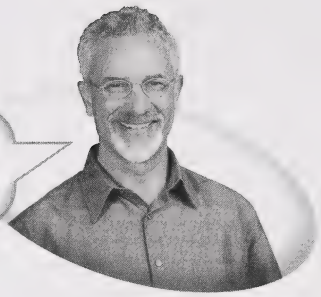
Lesson 1

Generating Electric Energy

When you look at electrical transmission lines that seem to stretch from tower to tower endlessly into the distance, do you wonder how and where the electricity that flows through these lines was generated? How long have these towers been part of the landscape? Where did the ideas about electricity originate? Who were some of the engineers and scientists responsible? These are some of the questions you will examine in this lesson.

Did you know?

In Alberta there are over 20 000 km of transmission lines transporting electricity to every corner of the province. Half of this electricity is generated by coal-fired power plants and another third by natural gas-fired plants. The remainder is generated by hydro-electric plants, windmills, and biomass plants (burning wood waste, garbage, or animal matter). Alberta is part of the western power grid. In times of high demand, electricity can flow in from power plants across western Canada and the United States, including electricity from nuclear power plants and wind-powered generators.



Before you start, you will explore where electricity comes from.

Starting Point
Activity

Where Does Electricity Come From?

Read the entire activity on page 99 of the textbook.

If you have access to a supervised laboratory, do **Part A**. If you do not have access to a galvanometer in a supervised laboratory but do have a small compass at home, do **Part B**. If you do not have a compass or if you want to make your own galvanometer, do **Part C**.

No matter which part you complete, keep your materials for "Find Out Activity: Generating Electric Energy" on page 100 of the textbook.

Part A

Follow steps 1 to 4 of "What to Do" carefully.

1. Record your observations. What is the effect of the moving magnet?

2. Answer questions 1 to 4 of "What Did You Discover?"

CHECK Check your answers on page 125 of the Appendix.

Part B

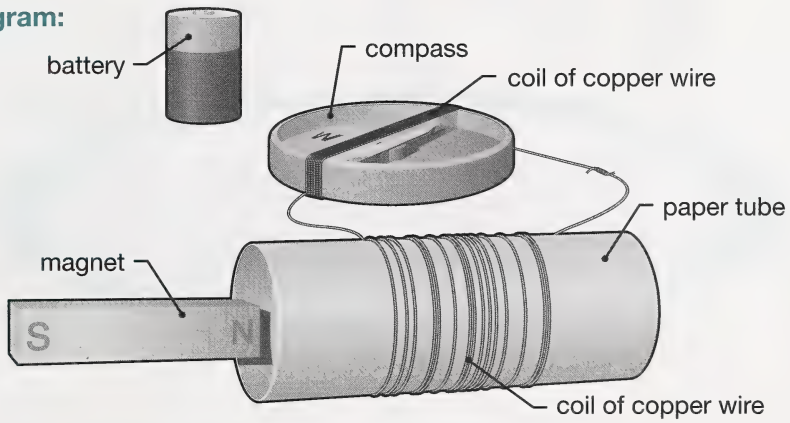
The following activity is similar to the activity in Part A. This activity, however, uses a compass rather than a galvanometer and uses materials and apparatus available at home.

Problem: How is electricity made?

Materials and Apparatus:

- 1.5 m of thin, copper wire
- toilet paper tube
- electrical tape
- bar magnet
- small compass
- small, 1.5-V, dry-cell battery

Diagram:



Procedure: Find a flat surface to carry out the activity; then follow these steps:

step 1: Wrap your compass along the north-south line with about ten complete turns of copper wire. The shorter free end of your copper wire should be about 20 cm in length. Using electrical tape, tape the wire to the back of your compass so the loops of wire around your compass do not come loose. Place your compass flat on your working surface, and turn the compass so the compass needle is pointing in the same direction as the loops of wire around the compass.

step 2: Touch the free ends of the wire to opposite terminals of the battery, and observe what happens to the compass needle as an electric current flows through the wire. Reverse the battery, and observe what happens to the compass needle. Set the battery aside.

step 3: Wrap the longer free end of the copper wire at least 20 times around the toilet paper tube. Tape the wire in place on the tube and twist the two free ends of the copper wire together to complete the circuit.

step 4: Move the magnet in and out of the paper tube.

step 5: Observe the compass needle. Record the effect of moving the magnet.

3. What was the effect on the compass needle when the battery was connected to the free ends of the copper wire?

4. What was the effect on the compass needle when the battery was reversed and then connected to the free ends of the copper wire?

5. What happened when you moved the magnet in and out of the tube?

6. Do you think moving the magnet induced an electric current in the copper wire? Why?

7. Answer question 1 to 4 of "What Did You Discover?" on page 99.

Check your answers on page 125 of the Appendix.

Part C

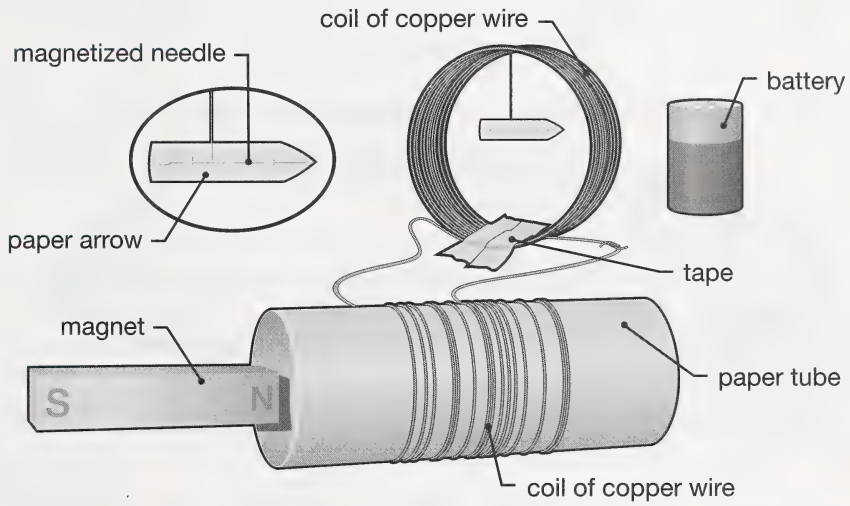
The following activity is similar to the activity in Part A. This activity, however, uses materials available at home to make your own galvanometer.

Problem: How is electricity made?

Materials and Apparatus:

- 3 m of thin, copper wire
- soft-drink can
- toilet paper tube
- electrical tape
- bar magnet
- needle
- thread
- paper
- scissors
- small, 1.5-V, dry-cell battery

Diagram:



Procedure: Find a flat surface to carry out the activity; then follow these steps:

step 1: Take the thin copper wire and wrap one end at least 10 times around the bottom of a soft-drink can, leaving about 20 cm free. Carefully slip it off the bottom of the can and tie the loops together with thread so they will not come apart.

step 2: Select a needle shorter in length than the diameter of the loops you made in step 1. Magnetize the needle. Stroke the needle at least 20 times in one direction only with a strong magnet. Lift the magnet each time you come to the end of the needle and return to your original starting point to make another pass.

step 3: When the needle is magnetized, pin it through a small paper arrow and suspend the arrow with thread in the middle of the looped wire (as shown in the diagram).

step 4: Tape the looped wire to a flat working surface so the suspended needle and arrow point in exactly the same direction as the loops.

step 5: Touch the free ends of the wire to opposite terminals of the battery, and observe what happens to the needle as an electric current flows through the wire. Reverse the battery, and observe what happens to the needle. Then set the battery aside.

step 6: Wrap the longer free end of the copper wire at least 20 times around the toilet paper tube. Tape the wire in place on the tube and twist the two free ends of the copper wire together to complete the circuit.

step 7: Move the magnet in and out of the paper tube.

step 8: Observe the needle. Record the effect of moving the magnet.

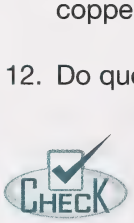
8. What was the effect on the needle when the battery was connected to the free ends of the copper wire?

9. What was the effect on the needle when the battery was reversed and then connected to the free ends of the copper wire?

10. What happened when you moved the magnet in and out of the tube?

11. Do you think moving the magnet induced an electric current in the copper wire. Why?

12. Do questions 1 to 4 of "What Did You Discover?" on page 99.



Check your answers on pages 125 and 126 of the Appendix.

Turn to page 100 of the textbook. Read the introductory paragraphs of "Generating Electric Energy."

13. What is an electric generator?

14. In the preceding Starting Point Activity, how did you generate electricity?

Check your answers on page 126 of the Appendix.

As you discovered in the reading, Michael Faraday is credited with the invention of the electric generator. If you have access to the Internet, you can find out more about Michael Faraday at the following website:

http://www.rigb.org/rimain/heritage/faradaypage.jsp

What can you do to increase the amount of electric energy produced by a generator? To answer this question, complete the following activity.

Find Out Activity

Generating Electric Energy

Read the entire activity on page 100 of the textbook.

Follow steps 1 to 6 of "What to Do" to complete this activity. You will be adapting the "Starting Point Activity" you explored earlier. Use the same apparatus you constructed, but you will need more wire so you can increase the number of coils for this activity.

15. Answer questions 1, 2, and 3 of "What Did You Find Out?"

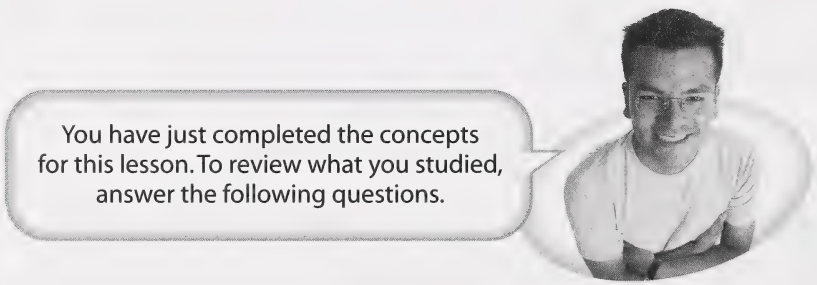
Check your answers on page 126 of the Appendix.

Now, turn to page 101 of the textbook and read the information in "Generating Electricity."

16. Identify the input energy, converter, and output energy for the generation of electricity.

Check your answer on page 126 of the Appendix.

If you have access to the Internet, do "Internet Connect" on page 101 of the textbook. You will learn about a Canadian inventor by the name of Thomas "Carbide" Wilson (1860–1915) and his many discoveries.



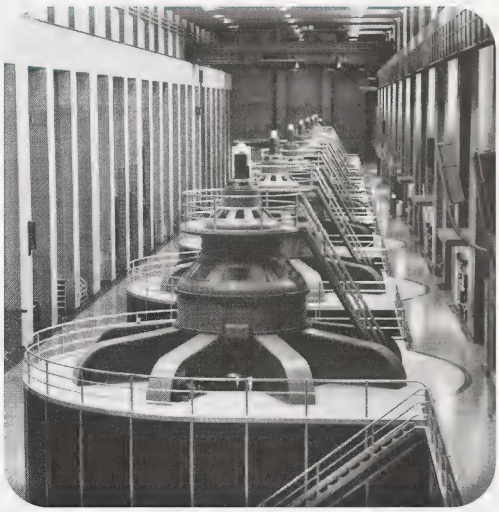
17. Answer questions 1, 2, and 3 of "Check Your Understanding" on page 101 of the textbook.

Check your answers on page 126 of the Appendix.

Go to page 5 of Assignment Booklet 2A and answer questions 1 to 5.

Lesson 2

Generating and Distributing Electric Energy



The photograph shows the tops of a series of electric generators (or dynamos). The turbines extend below the floor to where the water rushes through. The type of current produced by the generators is called alternating current. Alternating current is an electric current that repeatedly moves back and forth in the conductor. One back and forth motion of the current is called a cycle. Electric generation and transmission of electricity in Canada involves a 60-cycle-per-second alternating current.

Nicola Tesla (1856–1943) was the engineering genius who conceived of alternating current and its transmission and the electric motors that run on this form of electricity. Serbian by birth, Tesla moved to America as a young man where Westinghouse quickly recognized his talents. Westinghouse used his ideas in the construction of the first hydro-electric generator in North America at Niagara Falls. Alternating current became the standard and replaced the generation and transmission of direct current, which Westinghouse's rival, Edison, had advanced.

Did you know?

Did you know that Tesla was one of the inventors of the radio? Tesla's patents and ideas predated Marconi's, who is often given credit as the father of radio. If you have access to the Internet, you can find out more about Tesla and his amazing inventions and ideas at the following website:

http://www.pbs.org/tesla/index.html

In Lesson 1 you explored the generation of electricity by passing a coil of wire through a magnetic field. To review this process, launch the "Generator" applet on the *Science 24 Multimedia* CD. Observe what happens when you change the direction of the rotating coil and when you increase or decrease the speed of the rotating coil.

In this lesson you will extend what you studied in Lesson 1 to the commercial generation of electricity for home and business.

Turn to page 102 of the textbook and read the information in "Generating and Distributing Electric Energy." Pay careful attention to Figure 6.5.

1. What is a turbine? How is a turbine used to generate electricity?

2. Answer the question posed in "Reading Check" on page 102 of the textbook.

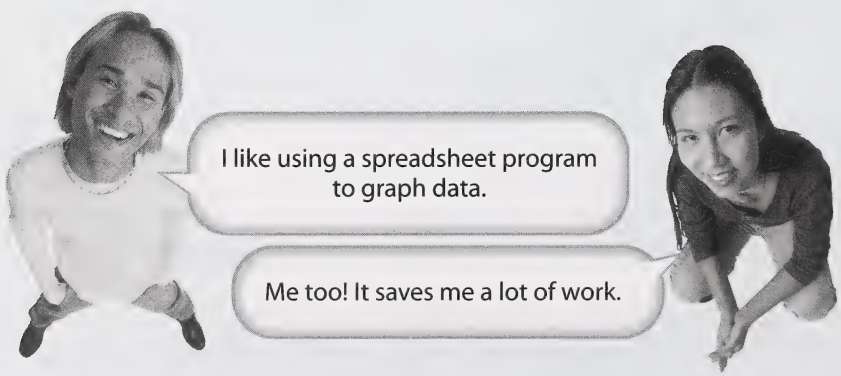
Check your answers on page 127 of the Appendix.

Investigation

6-A: Generating Electric Energy in Canada

Read through the entire investigation on page 103 of the textbook.

3. Follow the instructions outlined in step 2 of "What to Do" to graph the data in Table A.



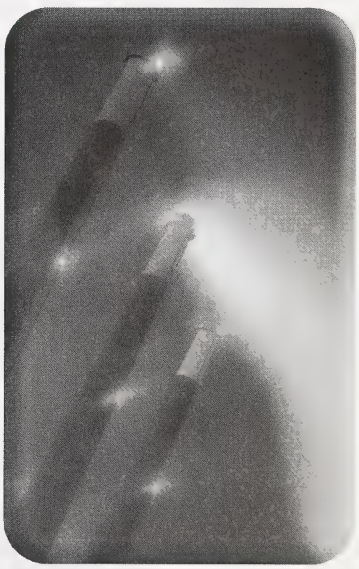
4. Answer questions 1 to 4 of "Analyze." **Note:** In question 4 the percent of electricity generated in Alberta by burning coal should be about 56%. This change does not affect the answer to the question.

Check your answers on pages 127 and 128 of the Appendix.

Next, you will investigate the generation of electricity in coal-fired, hydro-electric, and nuclear power plants.

Thermo-Electric Generation

Turn to page 104 of the textbook. Read the entire discussion under "Coal-Fired Thermo-Electric Generation."



5. Why are most coal-fired plants located close to sources of coal?

6. What is used in a coal-fired plant to spin the fan blades of the turbines?

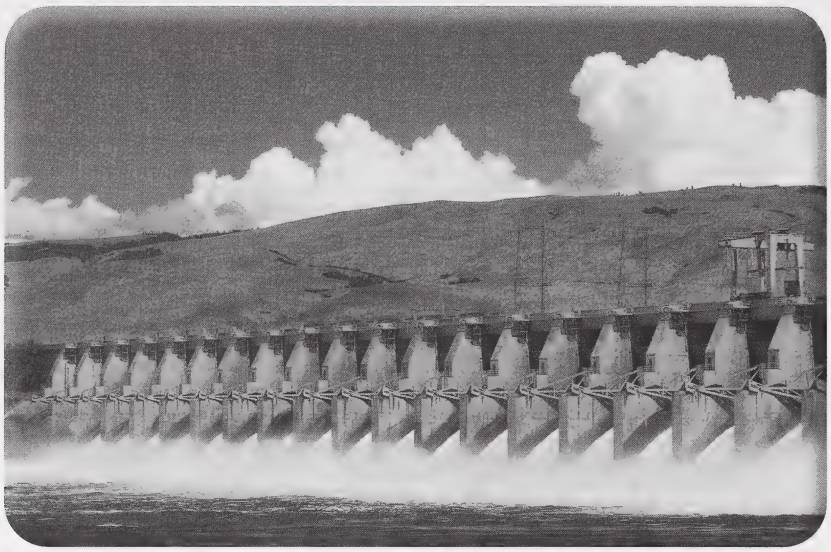
7. What part of the plant converts kinetic energy into electric energy?

8. What happens to the steam when it leaves the turbine?

9. What are the disadvantages of using coal to generate electricity?

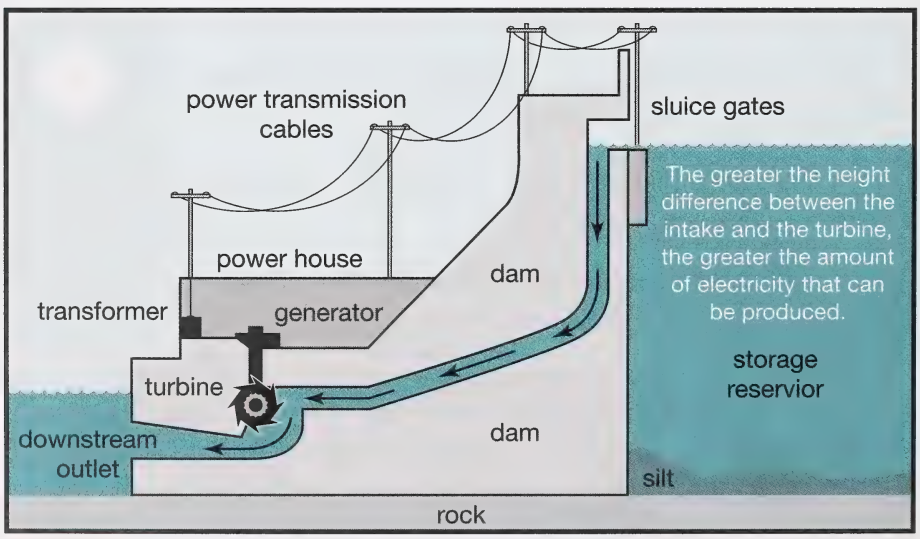
Check your answers on page 128 of the Appendix.

Hydro-Electric Generation



Turn to page 105 of the textbook and read "Electric Energy from Water."

As you discovered in Investigation 6-A, hydro-electricity accounts for 63% of Canada's electricity production. One of the largest hydro-electric developments in Canada is the James Bay Project in northern Quebec. Study the following diagram to see how hydro plants, like those in the James Bay Project, work.



10. What form of energy is stored in the reservoir?

11. Describe the energy conversions in the generation of hydro-electricity.

12. What is the main disadvantage of hydro-electric power?

Check your answers on page 128 of the Appendix.

An electric motor converts electric energy into kinetic energy. Did you know that you can use any electric motor as a generator? That is, you can use an electric motor to convert kinetic energy into electric energy? In the next investigation you will design and make a model hydro-electric plant.

Investigation

6-B: Making Hydro-Electric Energy

Read the entire investigation on page 105 of the textbook.

If you have access to a voltmeter and a small motor from a toy, complete this investigation. If you do not have access to these items, simply design your model.

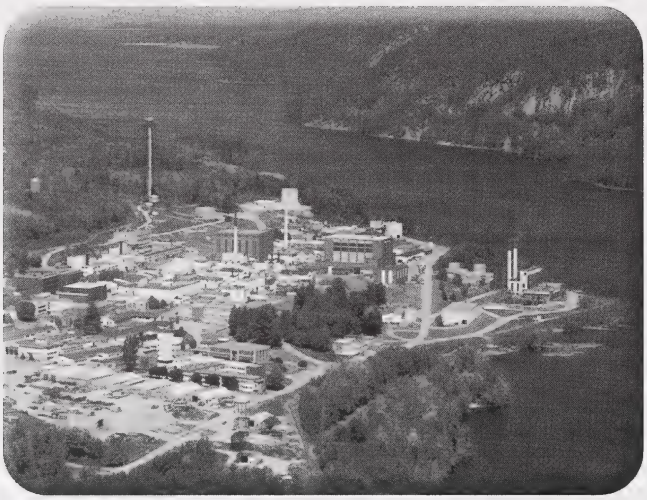
Carefully follow the instructions outlined in "Design Criteria" and "Plan and Construct." **Pay special attention to the safety precautions mentioned.**

13. Did your design work? How does your design compare to the one in the Appendix?

Check your answer on page 129 of the Appendix.

Nuclear Power Generation

Nuclear power plants represent the second largest generator of electricity in Canada. Did you know that Canada is a world leader in the design and development of nuclear power? By the end of 2003, there were 34 CANDU reactors operating or under construction around the world.



NATIONAL RESEARCH COUNCIL CANADA

Chalk River Laboratories

Did you know?

One of the primary nuclear power research sites is in Chalk River, Ontario. Research began at Chalk River just after World War II for continued allied atomic research. In 1956 the organization became a Crown corporation called Atomic Energy of Canada Limited.

If you would like to discover more about Canada's continuing contribution to nuclear research, access the Atomic Energy of Canada website.

http://www.aecl.ca

Turn to page 106 of the textbook and read "Energy from Splitting Atoms" and "Distributing Electricity."

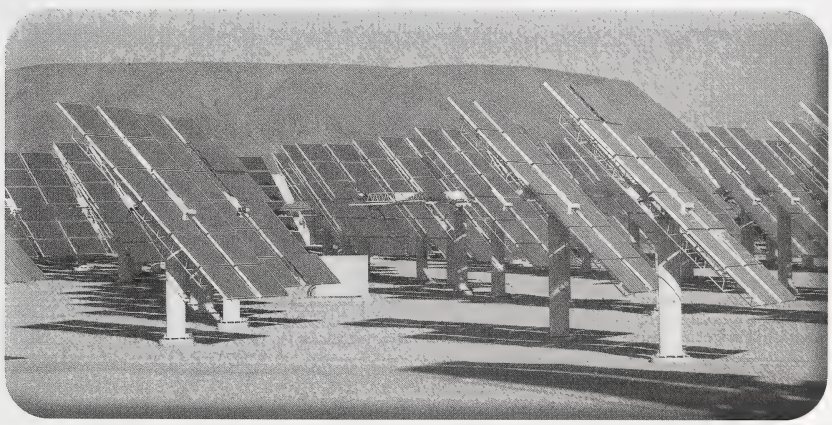
14. Describe the energy conversions in the generation of electricity in a nuclear power plant.

15. What is the main disadvantage of nuclear power?

Check your answers on page 129 of the Appendix.

Solar Power

Did you know that Earth receives as much solar energy every five minutes as all the energy all the people on the planet combined use in a month? Solar cells can tap some of this energy and convert it into electricity. Solar cells are more common than you think. In fact, most calculators have solar cells. Solar cells are also used to provide some of the electric energy for an office building; they can even help maintain the charge in a vehicle's battery, even on the coldest winter day.



Investigation

6-C: Solar Cells

Read the entire investigation on page 107 of the textbook.

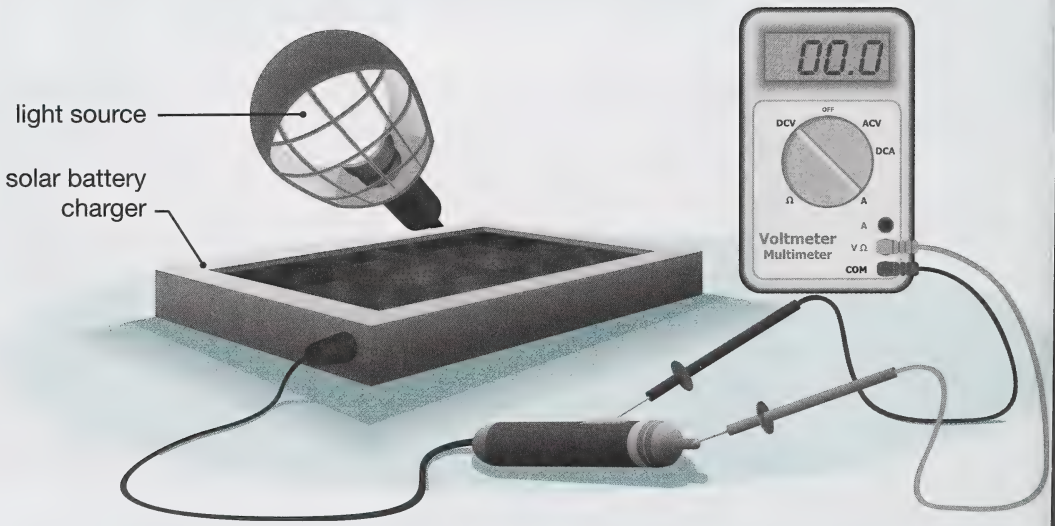
16. Write a hypothesis.

Check your answer on page 129 of the Appendix.

If you have access to a solar cell (such as a solar battery charger) and a voltmeter, do **Part A**. If you do not have access to these items, do **Part B**.

Part A

Follow the information outlined in "Design Criteria" and "Plan and Construct." **Pay special attention to the safety precautions mentioned**.



17. How did you control other variables?

18. What were your observations?

19. Write a conclusion for this investigation.

Check your answers on pages 129 and 130 of the Appendix.

Part B

The following table summarizes the results a couple of students obtained when they did this investigation. Use these results to answer question 19 in Part A.

Distance Between Light and Solar Panel (m)	Voltmeter Reading (V)
5	0.50
4	0.75
3	1.25
2	3
1	12

You should now have a good understanding of the generation of electricity. Now, answer the following questions to review what you studied.

20. Answer questions 1, 3, and 4 of "Check Your Understanding" on page 107 of the textbook.

Check your answers on page 130 of the Appendix.

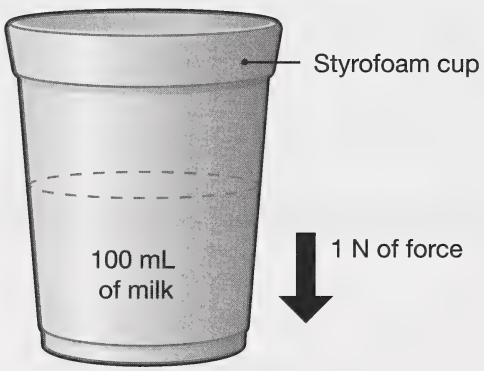
Go to page 6 of Assignment Booklet 2A and answer questions 6 to 9.

Lesson 3

Electric Energy and Power

Electric energy is an essential force at work and at home. Can you imagine getting a job done without the help of power tools. *Force*, *energy*, *work*, and *power* are terms you use in your everyday speech. But did you know that they have very specific meanings in science? In this lesson you will explore how these terms are used to help describe the role electricity plays in your life.

First, consider a simpler scenario. Suppose you had a small Styrofoam cup and filled it with approximately 100 mL of milk. The combined mass of the cup and milk would be about 100 g. To lift this cup, it would require a force of about 1 N. Force is measured in newtons (N), just as mass is measured in grams and kilograms.



work: a force acting through a distance

If you raised this cup of milk through a distance of 1 m to drink it, you would have performed 1 J (joule) of **work**. Work is accomplished by exerting a force through a distance. So, 1 J is the amount of work when a force of 1 N is exerted through a distance of 1 m. Both work and energy are measured in joules. Remember, energy is simply the ability to do work.

power: the rate of doing work

If you raised this cup in 1 s, you would have performed work at a rate of 1 J/s (joules/second). The rate of doing work is called **power**, and it is measured in watts (W). Now, 1 W is equal to 1 J/s. So, lifting the cup of milk to your lips in 1 s is equivalent to the power given off by a 1-W light bulb in 1 s.

Consider another situation.

Example

How much power does a 66-kg cross-country skier expend? Calorie counters estimate that a person who weighs 66 kg burns approximately 15 kcal/min, or about 3.6 kJ/min, cross-country skiing.

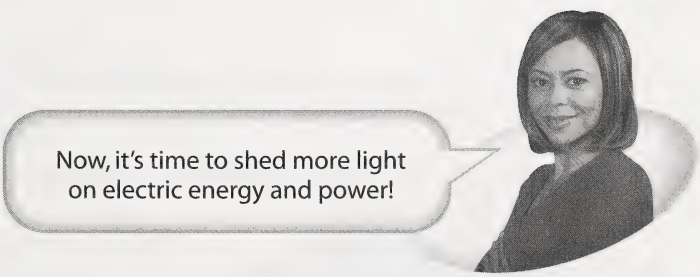
Solution

$$3.6\ \text{kJ} = 3.6 \times 1000\ \text{J}$$
$$= 3600\ \text{J}$$

$$3600\ \text{J/min} = \frac{3600\ \text{J}}{60\ \text{s}}$$
$$= 60\ \text{J/s}$$
$$= 60\ \text{W}$$

Remember:
J/s = joules/second
W = watts

So, a 66-kg cross-country skier expends power at the same rate as a 60-W light bulb.



Turn to page 108 of the textbook and read "Electric Energy and Power."

1. What is the difference between energy and work?

2. What is the difference between energy and power?

3. How many joules of energy would be used by a 60-W light bulb in 1 min?

Check your answers on page 130 of the Appendix.

As you discovered, energy and work are equivalent and power is the rate of doing work. Therefore, you can also define power as the rate at which energy is expended.

$$\text{power} = \frac{\text{energy}}{\text{time}}$$

Turn to pages 108 and 109 of the textbook. Work through the example in "Math Connect: Using a Formula to Calculate Power."

4. An aquarium light bulb uses 210 J of energy in 30 s. How much power does it use?

5. Speakers on a computer use 2400 J of electric energy every minute. How many watts of power do they use?

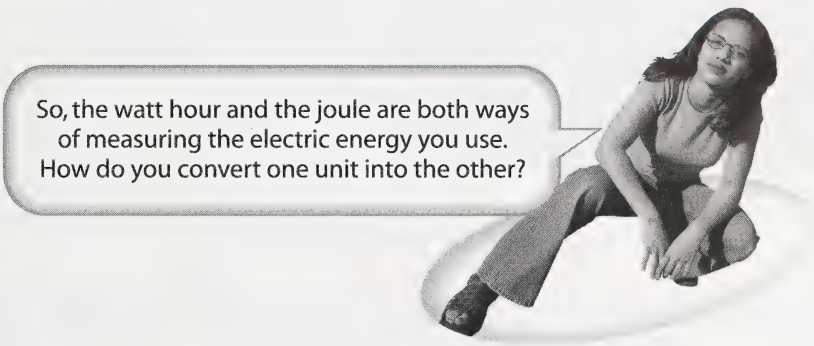
6. A light bulb uses 216 000 J of electricity every hour. How many watts of power does this bulb use?

Check your answers on pages 131 and 132 of the Appendix.

Turn to page 109 of the textbook. Read "What Do You Buy from the 'Power' Company?"; then work through the example in "Math Connect: Watt Hours."

7. Do questions 1 and 2 of "Solve These" at the bottom of page 109 of the textbook.

Check your answers on pages 132 and 133 of the Appendix.


So, the watt hour and the joule are both ways of measuring the electric energy you use. How do you convert one unit into the other?

Example

Convert 1 W•h into joules.

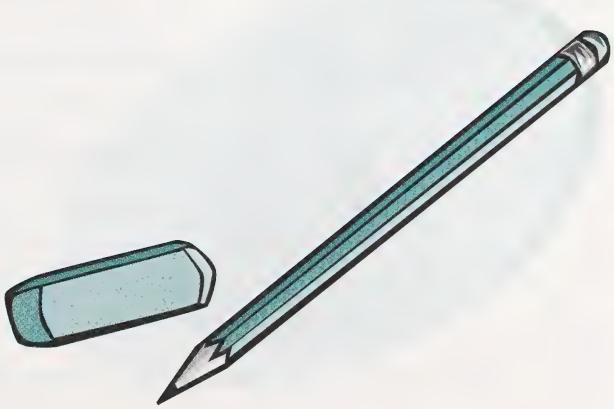
Solution

$$1\ \text{W}\cdot\text{h} = 1\ \text{W} \times 1\ \text{h}$$

$$= \frac{1\ \text{J}}{1\ \text{s}} \times 3600\ \text{s} \quad \leftarrow \text{There are 3600 s in an hour.}$$

$$= 3600\ \text{J}$$

Therefore, 1 W•h = 3600 J.



Example

When Jack used his hair dryer this morning, he used 810 000 J of electric energy. How many watt hours did Jack use?

Solution

$$810\,000\ \text{J} = \frac{810\,000\ \text{J}}{3600\ \text{J/W}\cdot\text{h}} \quad \leftarrow \text{There are 3600 J in 1 W}\cdot\text{h.}$$
$$= 225\ \text{W}\cdot\text{h}$$

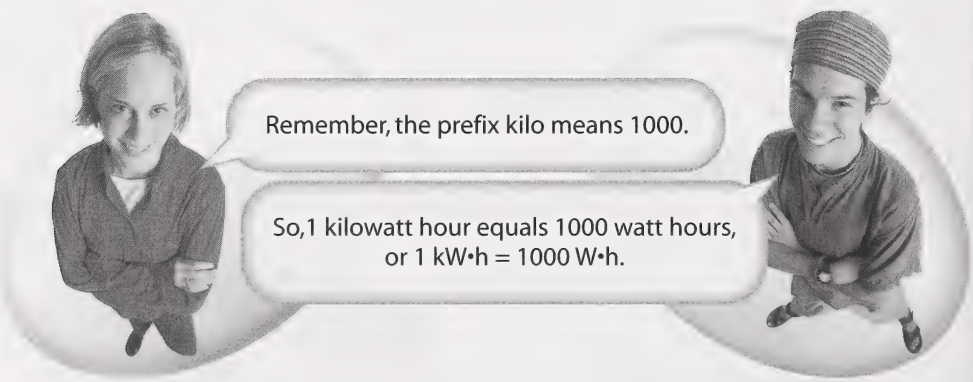
Jack used 225 W•h this morning.

8. How many joules are there in 3.5 W•h ?

9. Why do you think using watt hours is more convenient than joules to measure electricity consumption?

Check your answers on page 133 of the Appendix.

In the previous examples you discovered that the joule is a much smaller unit of electric energy than the watt hour. However, even the watt hour is too small to measure residential and commercial power usage. In the next part of this lesson you will explore the kilowatt hour.



Turn to page 110 of the textbook and read "Kilowatt Hours." Then work through the example in "Math Connect: Calculating Kilowatt Hours."

10. Do questions 1 and 2 of "Solve These" on page 110 of the textbook.

11. In November, Annie Manyberries and her family used 612 kW•h of electricity. Annie said this was the same as leaving almost ten 100-W light bulbs burning continuously for the month. Is Annie right?

CHECK Check your answers on pages 133 and 134 of the Appendix.

View the segment "Energy Consumption" on the *Science 24 Multimedia* CD. Follow the instructions and procedures carefully to proceed through the segment. You will see how much power various appliances use, and you will determine the cost of power for these appliances.

You should now have a good understanding of the concepts of this lesson. Answer the following questions to review what you covered.

12. Answer questions 1, 2, and 3 of "Check Your Understanding" on page 110 of the textbook.

CHECK Check your answers on page 135 of the Appendix.

Go to ... Go to pages 6 and 7 of Assignment Booklet 2A and answer questions 10 to 13.

Lesson 4

Efficiency and Saving Energy

efficiency: a measure of how much input energy is converted into useful output energy

When you use one of the burners on a stove, do you ever wonder what percentage of the energy heats the contents of the pot and what percentage is wasted? This question is about **efficiency**—the percent of the total energy used that is useful energy.

In this lesson you will evaluate the efficiency of some household appliances and explore ways to save energy.

Turn to page 111 of the textbook. Read the two introductory paragraphs of "Efficiency and Saving Energy."

1. Answer the question posed in "Reading Check" on page 111 of the textbook.

CHECK Check your answer on page 135 of the Appendix.

Find Out Activity

Heat Produced by Two Kinds of Light Bulbs

Read the entire activity on page 111 of the textbook.

If you have access to a supervised laboratory, do **Part A**. If you do not have access to a supervised laboratory, do **Part B**.

Part A

Follow the steps outlined in "What to Do" carefully. **Pay special attention to the safety precautions mentioned**.

Use a compact fluorescent bulb that produces the same amount of light as a 100-W incandescent bulb. Depending on the brand, the fluorescent bulb could be rated as low as 23 W.

2. Record your observations in the following table.

Elapsed Time (min)	Temperature over Incandescent Bulb (°C)	Temperature over Fluorescent Bulb (°C)
0		
1		
2		
3		
4		
5		

3. Graph your results using a line graph.

4. Did the two bulbs give off the same light intensity?

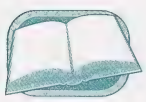
5. Which bulb used more electric energy to produce heat? How do you know?

Check your answers on pages 135 and 136 of the Appendix.

Part B

A student carried out this experiment and recorded the following data. Use this information to answer questions 3, 4, and 5 in Part A.

Elapsed Time (min)	Temperature over Incandescent Bulb (°C)	Temperature over Fluorescent Bulb (°C)
0	20	20
1	37	24
2	54	29
3	62	34
4	64	36
5	66	38



Turn to page 112 of the textbook and read "Efficiency." Then work through the example in "Math Connect: Calculating Efficiency."

6. Answer questions 1 and 2 of "Solve These" on page 112 of the textbook.

Check your answers on pages 136 and 137 of the Appendix.

In the preceding questions, you used the following formula to calculate the efficiency of an energy conversion.

$$\text{Percent efficiency of an electric device} = \frac{\text{useful energy output}}{\text{total electric energy input}} \times 100\%$$

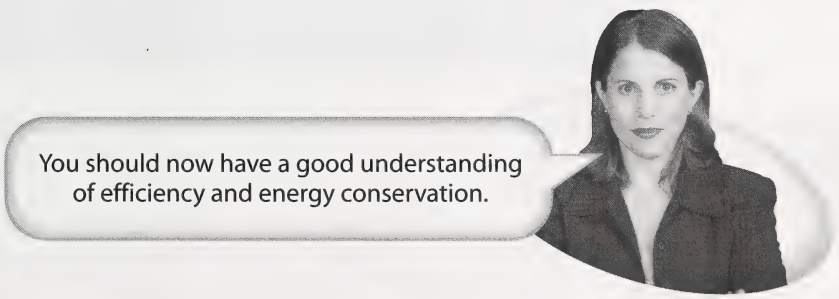
For additional information on the efficiency of appliances, view the segment "Efficiency" on the *Science 24 Multimedia* CD. Follow the instructions and procedures carefully to proceed through the segment.

Turn to page 113 of the textbook and read "It Pays to Be Efficient."

7. List five ways to conserve electric energy in the kitchen.

CHECK Check your answer on page 137 of the Appendix.

If you have access to the Internet, do "Internet Connect" on page 113 of the textbook. You will discover more ways to conserve energy.



8. Answer questions 1, 2, and 3 of "Check Your Understanding" on page 113 of the textbook.

CHECK Check your answers on pages 137 and 138 of the Appendix.

Go to ... Go to page 8 of Assignment Booklet 2A and answer questions 14 to 16.

Section 2 Review

In this section you explored electric energy. You investigated the generation of electricity, its transmission, and its distribution. For commercial electrical generation, you studied coal-fired, hydro-electric, and nuclear power plants. You also surveyed alternate sources, which included solar cells. In your exploration you reviewed how electric energy and power are measured and sold to consumers. To help control the cost of electric energy, you examined issues relating to efficiency and energy conservation.

Alternate sources of electric energy are becoming increasingly important as society tries to reduce effects of power generation on the environment. Have you seen wind turbine generators? In southern Alberta, near Pincher Creek and Fort MacLeod, there are generators that harness the power of winds. If you have access to the Internet, you can find out more about efforts in Alberta to limit the effects on the climate through green energy sources at the following website:

http://www.climatechangecentral.com/alternative_energy/alt_alberta_actions.html

You have now completed all of the concepts for this section. To review what you covered, insert the *Science.Connect 2 Student Multimedia* CD into your computer. Launch the "Electrical Energy" applet, starting with Part 1: Using Electrical Energy.

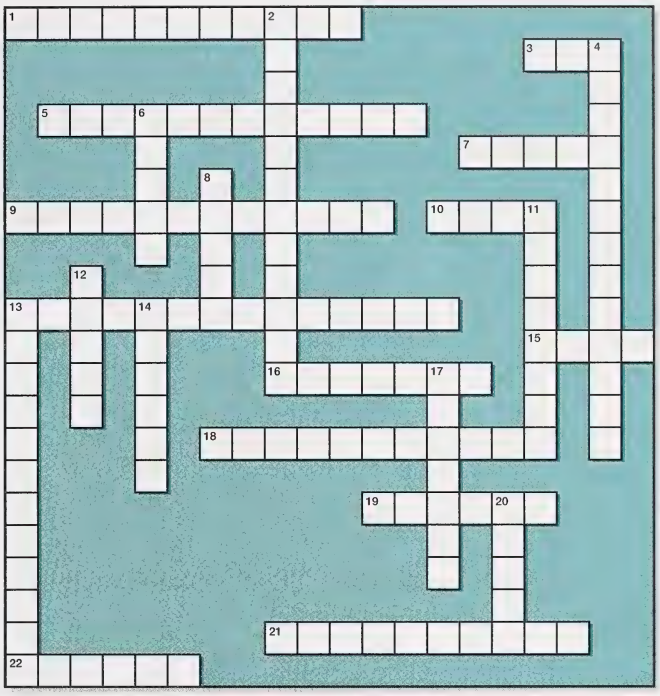
1. Complete the following puzzle.

Across

1. the output of a generator
3. the abbreviation of kilowatt hour
5. the saving of energy
7. the rate of doing work
9. a device that measures electric current
10. equivalent to energy
13. A coal-fired plant is one.
15. a unit of power
16. a set of rotating blades
18. a type of energy-efficient light bulb
19. measured in watt hours
21. describes the percentage of useful energy
22. a unit of force

Down

2. glowing with heat
4. a plant that generates electricity from water
6. an alternate source of energy
8. a unit of energy
11. 1000 watts
12. father of alternating current
13. the distribution of electric energy
14. a part of an electric generator
17. a plant that generates electricity by splitting atoms
20 a term describing power generation with limited environmental impact



2. Answer the following "Chapter 6 Review" questions on pages 114 and 115 of the textbook.

   a. question 1 of "Reviewing Key Terms"

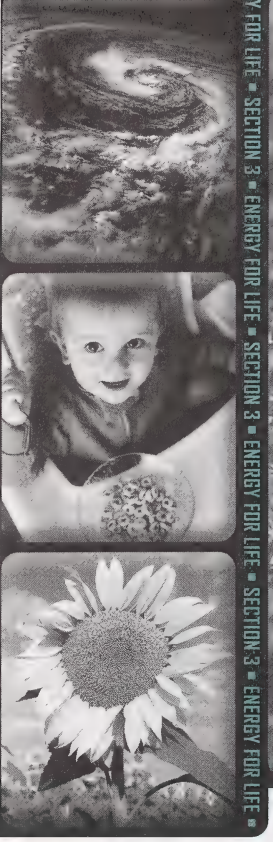
   b. questions 3, 4, 6, and 7 of "Understanding Key Ideas"

   c. question 9 of "Developing Skills"

   d. questions 10 to 13 of "Problem Solving/Applying"

   e. question 17 of "Critical Thinking"

Check your answers on pages 138 to 140 of the Appendix.



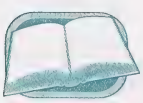
Section 3

ENERGY FOR LIFE

Sunflowers earn their name honestly. Not only are they coloured and shaped like miniature suns, during the day and while in the bud stage they follow the Sun across the sky. Regardless of the time of day, from dawn to dusk, every plant in a field of sunflowers is turned to face the Sun, possibly in an effort to capture the maximum solar energy. Once the sunflowers open into the radiance of yellow petals, they tend to face east possibly to avoid scalding their seeds in the hot afternoon sun.

Sunflower seeds are a rich source of energy—from cooking oil that even looks like liquid sunshine to the trail mix that many outdoor enthusiasts take for a quick boost. Many bird feeds contain an ample supply of sunflower seeds, which chickadees and other wild birds feed on during cold, winter days.

In this section you will explore how green plants, like sunflowers, convert solar energy into sugars and starches—energy sources without which people and animals could not survive. You will investigate how people and animals convert the stored energy in plants into usable energy.



Turn to pages 116 and 117 of the textbook. Read the introduction to "Chapter 7: Energy for Life." Pay particular attention to the points in "What You Will Learn," "Why It Is Important," and "Skills You Will Use." These provide a quick overview of what you will cover in this section.

Lesson 1

Nature's Energy Conversions

Western Canada has a well-deserved reputation as being the breadbasket of the world. Wheat grown on the prairies is a high-protein grain that is excellent for making bread. Breads and pastas are staples that provide needed carbohydrates and proteins to a hungry world population.

In this lesson you will investigate two energy conversions: energy from the Sun to green plants and energy from green plants to humans and animals.

Starting Point Activity

Using Glucose for Energy

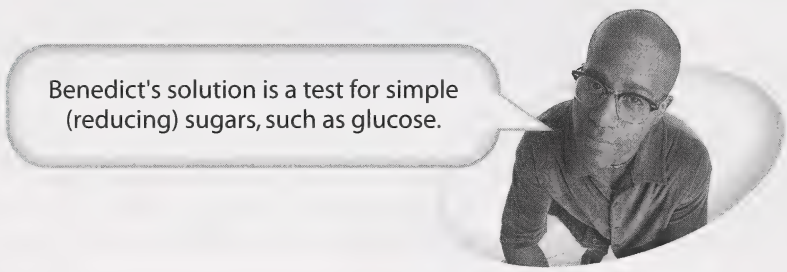
Read the entire activity on page 117 of the textbook.

If you have access to a supervised laboratory, do **Part A**. If you do not have access to a supervised laboratory, do **Part B**.

Part A

Follow the instructions outlined in "What to Do." Your teacher may have already prepared a glucose solution—by adding 1 g of glucose (sugar) to 100 mL of water—and a yeast solution—by adding 1 g of dry yeast to 100 mL of water.

Pay special attention to the following safety precautions. This activity should only be completed under the direct supervision of a teacher. Benedict's solution is toxic. It contains sodium citrate, sodium carbonate, and copper sulfate. For your protection, you must wear a lab coat (or apron) and goggles. Because you will be handling tests tubes placed in a hot-water bath (at a constant 40°C), it is recommended that test tube holders be used. Point the open ends of the test tubes away from yourself and others. Remember, only put small amounts of chemical into the test tubes at a time. If you splash yourself with Benedict's solution, wash with plenty of water immediately.



1. What did you observe in each test tube?
2. Write a conclusion about the action of the yeast.
3. What is the purpose of test tube 1 and test tube 2?

CHECK Check your answers on page 141 of the Appendix.

Part B

A student carried out this experiment. The following information was recorded. Use this information to answer questions 2 and 3 in Part A.

Colour	Test Tube			
	1	2	3	4
before heating	blue-green	blue-green	blue-green	blue-green
after heating	deep blue	red-orange	yellow-green	blue-green

Turn to page 118 of the textbook. Read the introductory paragraphs of "Nature's Energy Conversions." In the reading you will analyze the process of **photosynthesis**.

photosynthesis: a process in green plants that converts carbon dioxide and water into glucose and oxygen

4. What is photosynthesis?

5. Where does photosynthesis occur?

6. What is the role of chlorophyll?

7. a. What are the ingredients of photosynthesis?

   b. What are the products of photosynthesis?

8. Compete the activity in "Try This!" on page 118 of the textbook.

Check your answers on pages 141 to 143 of the Appendix.

Did you know?

One of the products of photosynthesis in green plants is oxygen. Did you know that there was little or no oxygen in Earth's atmosphere 4.5 billion years ago? Hydrogen, helium, methane, and ammonia were the main components of the early atmosphere. Over the next 500 million years, most of the hydrogen and helium was lost to space. Nitrogen, carbon dioxide, and water vapour—all expelled by volcanoes—became the dominant gases. Then through photosynthesis in algae and plants, the amount of oxygen in the atmosphere increased. Oxygen, today, makes up about 21% of the atmosphere.

If you have access to the Internet, you can find out more about the evolution of Earth's air at the following site:

http://www.ux1.eiu.edu/~cfjps/1400/atmos_origin.html

You can also try words like *early atmosphere* and *origin of atmosphere* in any of the Internet's search engines.

Next, you will explore how the glucose manufactured by green plants is used by animal cells to obtain energy. This process is called **cellular respiration**. Turn to page 119 of the textbook and read the information in "Cellular Respiration" and "Two Energy Conversions."

cellular respiration: a process used by all plant and animal cells to obtain energy from food

9. Where does cellular respiration occur?

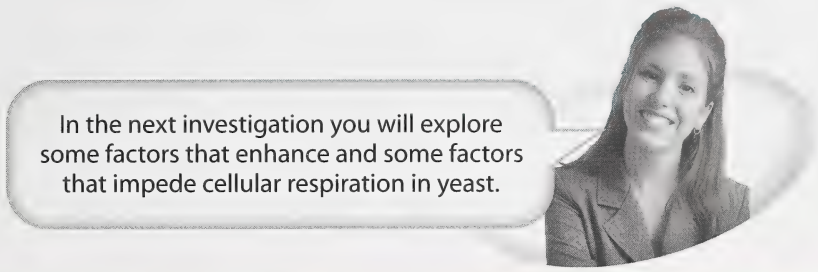
10. a. What are the reactants of cellular respiration?

    b. What are the products of cellular respiration?

11. Look at the equations for cellular respiration and photosynthesis. What do you notice?

12. What are the converters in photosynthesis and cellular respiration?

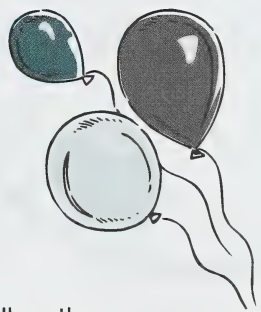
Check your answers on page 143 of the Appendix.


In the next investigation you will explore some factors that enhance and some factors that impede cellular respiration in yeast.

Investigation

7-A: Balloons Simulate Respiration

Read the entire investigation on pages 120 and 121 of the textbook.



If you have access to a supervised laboratory, do **Part A**. If you do not have access to a supervised laboratory, do **Part B**.

Part A

Obtain the required materials and apparatus. Then follow the steps of the procedure carefully. **Pay special attention the safety precautions mentioned.**

13. Record your observations in a table similar to the following.

Test Tube	Contents	Changes in the Test Tube	Sketch
1			

14. Answer the following on page 121 of the textbook.

    a. questions 1 to 4 of "Analyze"

    b. questions 5, 7, 8, and 9 of "Conclude and Apply"

    c. question 10 of "Extend Your Knowledge"

Check your answers on pages 144 and 145 of the Appendix.

Part B

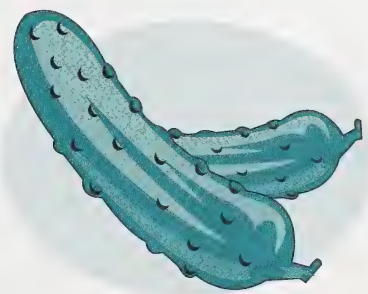
A student carried out this experiment. The following information was recorded. Use this information to answer questions 14.a. and 14.b.

Test Tube	Contents	Changes in the Test Tube	Sketch
1	• 5 mL yeast mixture	• Yeast does not appear to grow.	
2	• 5 mL yeast mixture •1 g sugar	• Yeast grows and increases in volume. • bubbling in test tube	
3	• 5 mL yeast mixture •1 g sugar • 25 drops vinegar solution	• Yeast does not grow much. • some bubbling	

4	• 5 mL yeast mixture • 1 g sugar • 25 drops bleach solution	• Yeast does not appear to grow.	
5	• 5 mL yeast mixture •1 g sugar • 25 drops ammonia solution	• Yeast does not appear to grow.	
6	• 5 mL yeast mixture •1 g sugar • 25 drops fertilizer solution	• Yeast grows more rapidly than in test tube 2. • bubbling in test tube	

15. You saw that yeast converts sugar into energy to grow. Turn to page 121 of the textbook and do the questions in "Try This!"

16. You discovered that vinegar inhibits the growth of yeast. Explain why vinegar is used to pickle cucumbers.



CHECK Check your answers on pages 145 and 146 of the Appendix.

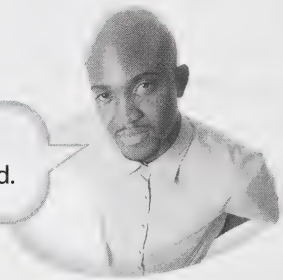
In Section 2 you discovered that no energy conversion is 100% efficient in the production of useful energy. This is also true in cellular respiration. To learn more, read "Energy Conversion: Plants to Animals" on page 122 of the textbook. Study Figure 7.4 carefully.

17. What is an ecological pyramid?

18. Approximately what percentage of energy is transferred from one level to another?

19. Approximately what percentage of the energy in the grain is available to the owl in Figure 7.4?

CHECK Check your answers on page 146 of the Appendix.



You have now completed the concepts for this lesson.
Answer the following questions to review what you covered.

20. Answer questions 1 to 4 of "Check Your Understanding" or page 122 of the textbook.

CHECK Check your answers on page 146 of the Appendix.

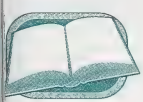
Go to ... Go to pages 1 and 2 of Assignment Booklet 2B and answer questions 1 to 5.

Lesson 2

The Need for Energy

When healthy, the human body maintains a fairly steady temperature of 37°C. A difference of two or more degrees means something is wrong! Slight fevers are common with the flu or a cold, but a temperature over 42°C results in serious damage to the central nervous system and major organs. In the cold your skin temperature may drop, but your core temperature normally stays the same. However, if your body temperature were to drop below 33°C, you would lose consciousness!

In this lesson you will investigate how your body regulates its temperature.



Turn to page 123 of the textbook and read "The Need for Energy."

homeostasis: a steady state

metabolism: the rate at which a body uses energy

1. What does **homeostasis** mean in regards to your body?
2. What strategies does your body have to regulate temperature?
3. What does it mean if a person is said to have a high **metabolism**?

Check your answers on pages 146 and 147 of the Appendix.

Just as you have patterns in your activities over the course of a day, your body temperature follows natural rhythms. To explore these rhythms, complete the following investigation.

Investigation

7-B: Daily Temperature Changes

Read the entire investigation on page 124 of the textbook.

4. Draw the line graph as described in "What to Do."
5. Answer questions 1, 2, and 3 of "Analyze."

CHECK Check your answers on pages 147 and 148 of the Appendix.

You have just completed the concepts for this lesson. To review what you studied, answer the following questions.

6. Answer questions 1, 2, and 3 of "Check Your Understanding" on page 124 of the textbook.

CHECK Check your answers on page 148 of the Appendix.

Go to ... Go to page 2 of Assignment Booklet 2B and answer questions 6 to 8.

Lesson 3

Sources of Energy

carbohydrates: foods consisting of compounds of carbon, hydrogen, and oxygen; main source of energy for the body

fat: a nutrient that is a rich source of energy for the body

protein: building block and source of energy for the body

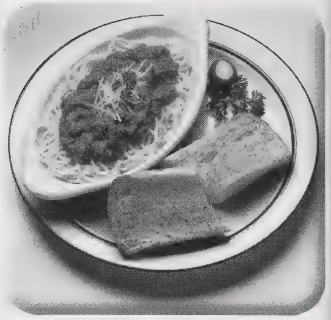
Regardless of which part of the country you live in or what your food preferences are, your diet should include enough variety to provide the energy and vitamins and minerals to maintain a healthy and active lifestyle. Today's fast foods may not provide all the necessary nutrients or protect against disease as the foods eaten two or more generations ago. For example, did you know that those who follow a traditional Inuit diet of fish and sea mammals have a much lower chance of developing heart disease?

Canada's Food Guide provides dietary guidelines everyone should follow. These guidelines have been adapted for northern Canadian residents, reflecting differences in availability and culture. If you have access to the Internet, you can see what these recommendations are at the Health Canada website.

http://www.hc-sc.gc.ca/hpfb-dgpsa/onpp-bppn/food_guide_rainbow_e.html

In this lesson you will explore the energy available in various foods. In particular, you will look at **carbohydrates**, **fats**, and **proteins**.

Carbohydrates



Turn to page 125 of the textbook and read the introductory paragraphs of "Sources of Energy."

1. What percentage of your diet do health experts recommend be carbohydrates?

2. Which simple carbohydrate is the main source of energy for the human body?

3. What is the glucose your body does not immediately need converted into?

4. What is "carbo. loading"?

Check your answers on pages 148 and 149 of the Appendix.

Fat

Another important source of food energy are fats. Health Canada recommends that 10–30% of your caloric intake should come from fats.

Read "Fat: There When You Need It" on page 126 of the textbook.

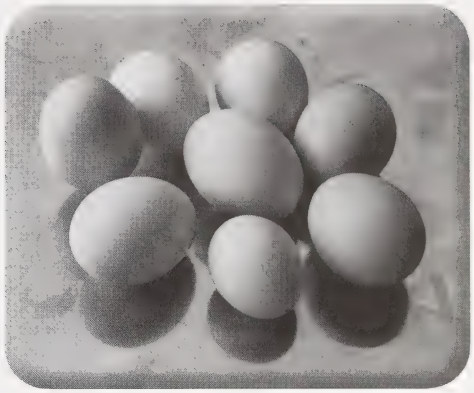
5. Why do people need body fat?

6. What are the two categories of fat people eat? Name the main source of each category.

7. Which contains more energy—a gram of fat or a gram of carbohydrates? How many times more?

Check your answers on page 149 of the Appendix.

Protein



Gram for gram, proteins and carbohydrates have the same energy value. Find out more about protein as an energy source and as a building block of your body. Read "Protein: The Last Choice" on page 127 of the textbook.

8. When does your body make use of protein as an energy source?

9. What are the main sources of dietary protein?

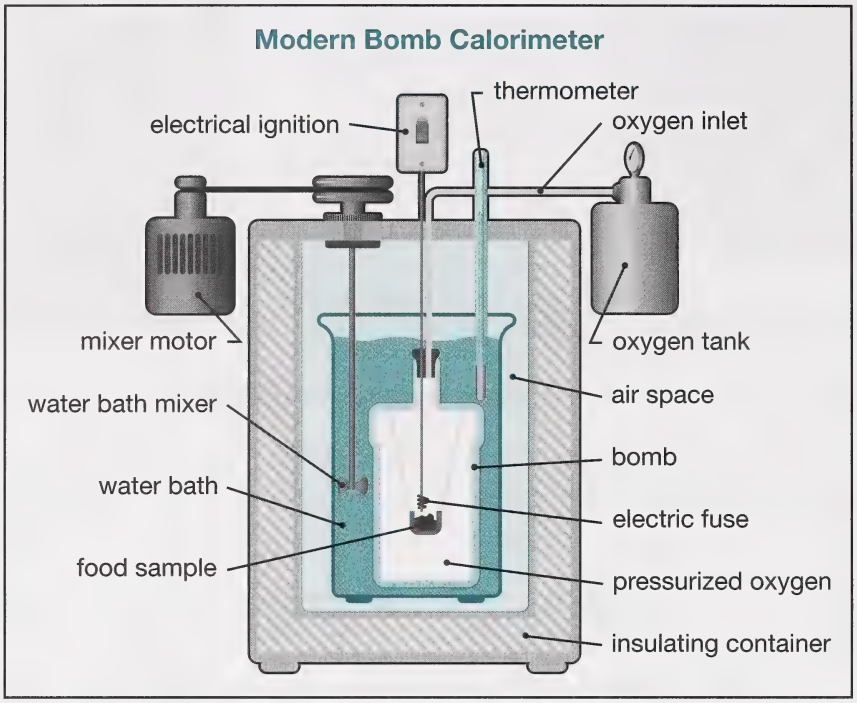
10. Some people go on extreme diets to lose weight. Why are extreme diets dangerous?

Check your answers on page 149 of the Appendix.

Have you wondered how scientists measure food energy? The chemist whose work is still referred to today in measuring calories in foods is Wilbur Atwater. Atwater invented the bomb calorimeter—a device that measures the heat produced by a food sample burned in pure oxygen.

Wilbur Atwater (1844–1907)

The following diagram shows a modern bomb calorimeter.



The food sample is placed in the inner metal container where it burns in the presence of oxygen. The heat released warms the water surrounding the inner container. The mass of the food sample and the rise in water temperature together are used to determine the caloric energy of the sample.

Using his bomb calorimeter, Atwater determined that 1 g of carbohydrates or protein contains about 4 kcal. (Remember, the calories you see on labels are kilocalories.) He also determined that 1 g of fat contains about 9 kcal. This is Atwood's 4-9-4 rule.

To determine the calories in a serving of food, first determine the grams of carbohydrates, fats, and proteins in the sample. Then use the following formula:

$$\begin{aligned}\text{Calories in serving} = {} & 4 \times (\text{grams of carbohydrates per serving}) \\ & + 9 \times (\text{grams of fat per serving}) \\ & + 4 \times (\text{grams of protein per serving})\end{aligned}$$

Example

A 30-g serving of shredded wheat contains 3.5 g of protein, 0.7 g of fat, and 24 g of carbohydrates. About how many calories are there in a serving of shredded wheat?

Solution

Write down what you know.

calories = ?
carbohydrates = 24 g
fats = 0.7 g
protein = 3.5 g

Use the formula.

$$\begin{aligned}\text{Calories in serving} &= 4\times(\text{grams of carbohydrates per serving})\\ &\quad +9\times(\text{grams of fat per serving})\\ &\quad +4\times(\text{grams of protein per serving})\\ &=(4\times 24)+(9\times 0.7)+(4\times 3.5)\\ &=96+6.3+14\\ &=116.3\end{aligned}$$

There are about 116 kcal in a serving of shredded wheat.

11. In the preceding example, the carbohydrates, fats, and proteins do not add up to 30 g in the 30-g serving of shredded wheat. Why is that?

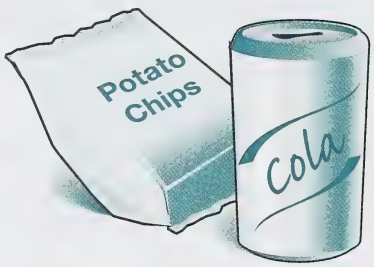
Check your answer on page 149 of the Appendix.

You will use Atwater's rule in the next investigation.

Investigation

7-C: Is There Energy in Common Snack Foods?

This investigation is a bit different from the investigation outlined on pages 128 and 129 of the textbook. You may want to read over the investigation in the textbook to see how a home-made calorimeter might be used to measure the relative caloric content in several different snack foods.



Problem: Which snack foods contain the most energy?

Materials: nutrition information from the labels of three of your favourite snack foods

Diagram:

NUTRITION INFORMATION
INFORMATION NUTRITIONNELLE
Per 16-g serving (1 bar) / Par portion de 16 g (1 barre)

ENERGY / ÉNERGIE	**83 Cal/350 kJ**
PROTEIN / PROTÉINES	**1.2 g**
FAT / MATIÈRES GRASSES	**4.3 g**
CARBOHYDRATE / GLUCIDES	**10 g**

Procedure:

step 1: For each snack food, record the number of grams of carbohydrates, fats, and proteins in one serving.

step 2: Determine how many grams of carbohydrates, fats, and proteins there would be in 10 g of the snack food. For example, if the serving size is 30 g, divide the number of grams by 3.

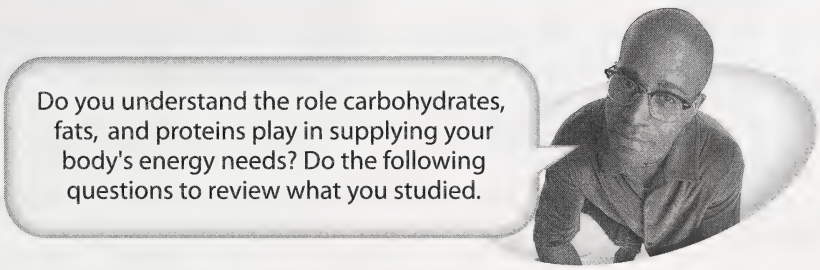
$$30\ g \div 3 = 10\ g$$

step 3: Use Atwater's rule to estimate the number of calories (kcal) there are in each 10-g sample.

12. Construct a bar graph showing your results.

13. Which snack contained the most energy?

Check your answers on pages 149 to 151 of the Appendix.


Do you understand the role carbohydrates, fats, and proteins play in supplying your body's energy needs? Do the following questions to review what you studied.

14. Answer questions 1 and 2 of "Check Your Understanding" on page 129 of the textbook.

Check your answers on page 151 of the Appendix.

Go to page 3 of Assignment Booklet 2B and answer questions 9 to 14.

Lesson 4

Human Energy Needs Change

If you have ever fed a small child, you will agree that they have definite likes and dislikes, just as older people do. Of course, because they are so active and because they are developing so quickly, kilogram for kilogram, their energy needs are significantly higher than most adults.

In this lesson, you will investigate how people's energy needs change as they grow older.

Turn to page 130 of the textbook and read the introductory information of "Human Energy Needs Change." Then read "Career Connect" at the bottom of the page.

1. How does a developing fetus get nutrition?
2. Why are breast-fed babies less likely to get sick?
3. What is meant by metabolic needs?
4. Why do young people require large amounts of energy during puberty?
5. Why do breast-feeding mothers have a high metabolism?

CHECK Check your answers on pages 151 and 152 of the Appendix.

In the first part of this lesson you were introduced to the term *metabolic needs*. In the next part of this lesson you will explore factors that affect metabolism.

Read "What Affects Metabolism?" on page 131 of the textbook.

6. List the factors that affect metabolism.

7. List two ways to avoid gaining unnecessary weight.

CHECK Check your answers on page 152 of the Appendix.

If you have access to the Internet, complete the activity outlined in "Internet Connect" on page 131 of the textbook.

You should now have a good understanding of the energy needs of people at various stages in life. Do the following questions to review what you covered.

8. Answer questions 2, 3, and 4 of "Check Your Understanding" on page 131 of the textbook.

CHECK Check your answers on page 152 of the Appendix.

Go to ... Go to page 4 of Assignment Booklet 2B and answer questions 15 to 18.

Section 3 Review

In this section you examined two of nature's energy conversions: photosynthesis in green plants and cellular respiration in plants and animals. You then explored people's need for energy, what the main sources of this energy are, and how people's energy needs change as they grow older.

The need for energy increases in people and animals when the weather turns colder. The bird in the photograph frequents this feeder on brisk, winter days. It is taking advantage of the energy stored in the bird seeds the home-owner has thoughtfully provided. Birds have a much higher body temperature than people and a proportionately higher metabolism. Gram for gram, their energy needs are significantly higher than yours.

You have now completed the concepts for this section. To further your understanding, do the following "Chapter 7 Review" questions on pages 132 and 133 of the textbook. If necessary, go back and read over parts of this section as you answer the questions.

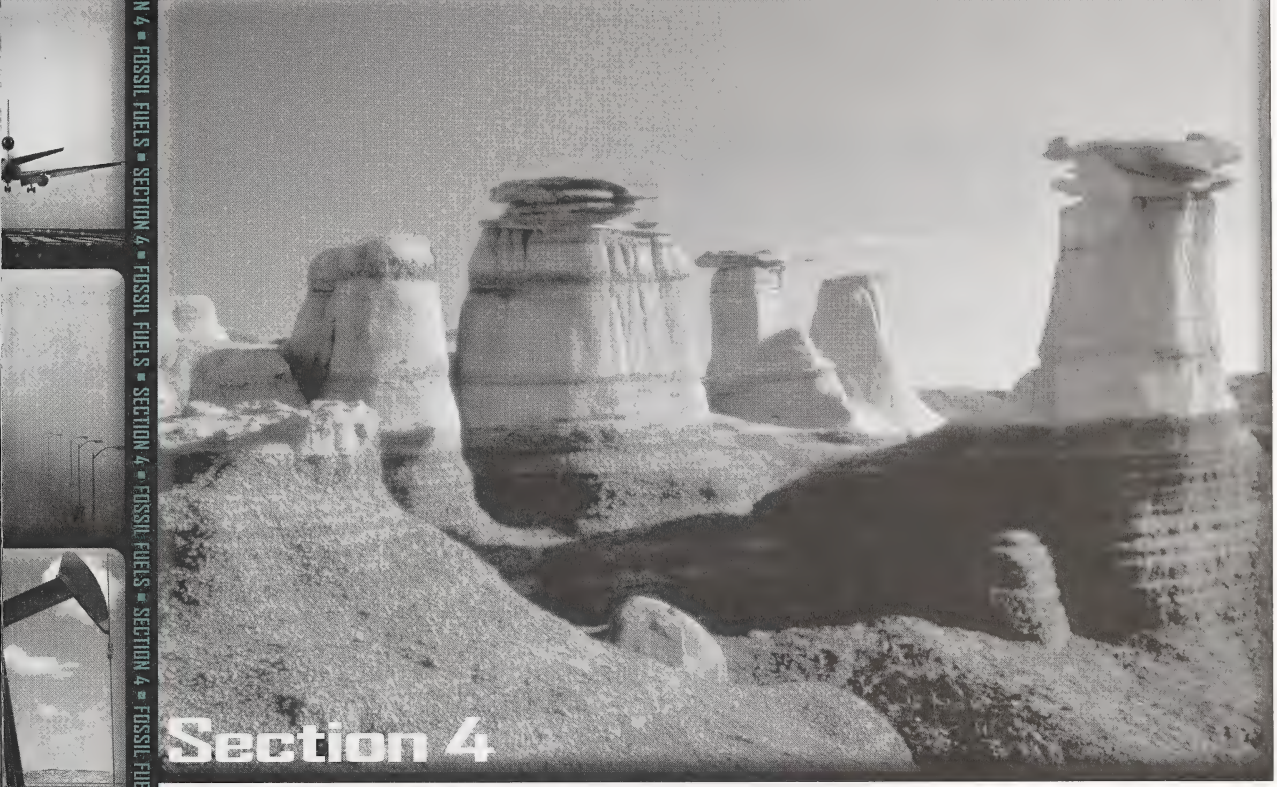
1. Answer questions 1 to 5 of "Reviewing Key Terms."

2. Answer questions 6 to 11 of "Understanding Key Ideas."

3. Answer questions 13 and 14 of "Problem Solving/Applying."

4. Answer question 16 of "Critical Thinking."

CHECK Check your answers on pages 152 to 154 of the Appendix.

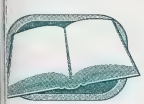


Section 4

FOSSIL FUELS

If you have travelled through the badlands near Drumheller, Alberta, you will have noticed the layers of sediment in the hills along the Red Deer River. These layers were laid down over millions of years when ancient inland seas covered this part of North America. Fossils exposed by erosion have contributed to the knowledge of the past. The Royal Tyrell Museum in Drumheller, Alberta, is a world-class facility for the study and public display of dinosaur remains.

Fossils are not the only things covered by layers of sediment. Coal, oil, and natural gas—fossil fuels—are all found in the area. In this section you will explore how these fuels were formed over millions of years. You will also explore how they are recovered, and you will investigate the problems associated with their extraction and use.



Turn to pages 134 and 135 of the textbook and read the introduction to "Chapter 8: Fossil Fuels." Check out the points outlined in "What You Will Learn," "Why It Is Important," and "Skills You Will Use." These will give you a quick overview of what you will cover in this section.

Lesson 1

What Are Fossil Fuels?

GLENBOW ARCHIVES N-3106-11

The modern development of Alberta began with the fur trade. Later, as settlers opened up the land to agriculture, the need for coal for the railroad and to fuel industry and homes led to the search for **fossil fuels**. The photograph you see is of the Number 1 mine that operated near Canmore from 1886 to 1916. The coal-fired steam locomotives of the Canadian Pacific Railroad, completed in 1885, relied on the high-quality coal from this part of Canada. Today, a little over half of Alberta's electricity is generated in coal-fired plants throughout the province.

fossil fuel: a fuel formed from the remains of organisms that lived millions of years ago

Oil and natural gas play a major role in Alberta's and Canada's economy. Oil was first discovered in Canada in 1857 in southwestern Ontario at Petrolia (near Sarnia). In Alberta oil was discovered in 1914 at Turner Valley and near Leduc in 1947. Today, the development of the Athabasca Oil Sands is tapping into one of the world's largest oil reserves. Natural gas, which supplies most western Canadian homes, was first discovered in 1910 near Medicine Hat.

In this lesson you will examine what fossil fuels are, how they were formed, and how they are used.

Starting Point
Activity

Oil and Water

Read the entire activity on page 135 of the textbook.

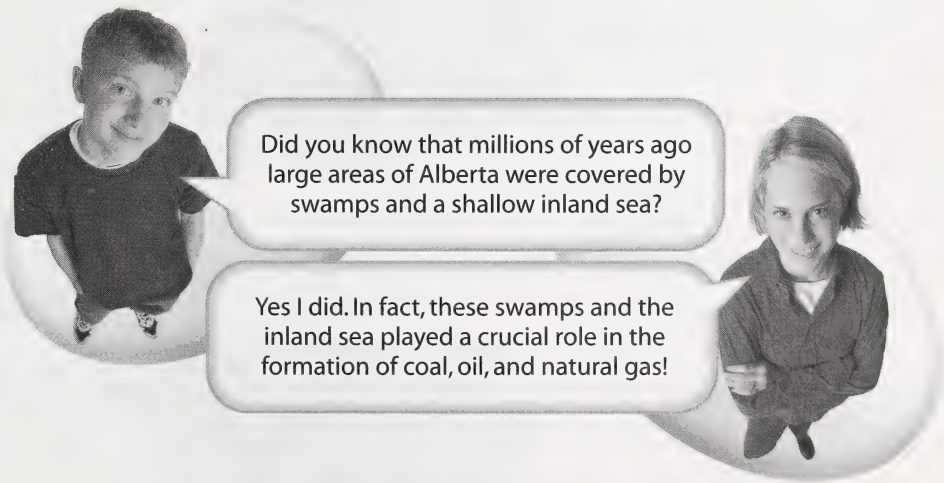
1. Answer question 1 of "What to Do." To help you answer some of the questions in this activity, visit the website given in "Internet Connect." You may also check the prices of the items at your local service station and grocery store.

2. When do some experts predict the demand for oil will outstrip supply?

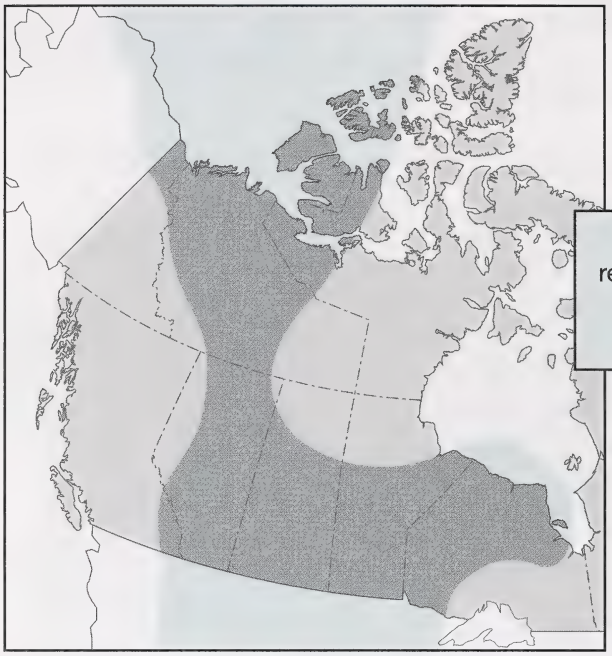
3. Why are fossil fuels often referred to as non-renewable resources?

CHECK

Check your answers on page 154 of the Appendix.


Did you know that millions of years ago large areas of Alberta were covered by swamps and a shallow inland sea?
Yes I did. In fact, these swamps and the inland sea played a crucial role in the formation of coal, oil, and natural gas!

Late Cretaceous



The coloured regions show the area the inland sea covered.

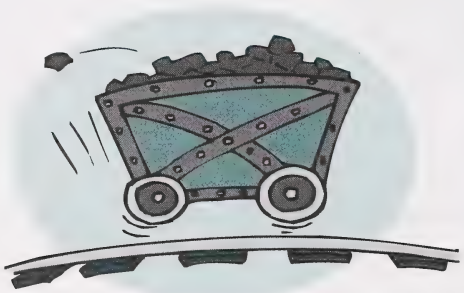
Turn to pages 136 and 137 of the textbook. Read the introductory information of "What Are Fossil Fuels?"

4. Why are coal, oil, and natural gas called fossil fuels?

5. a. Name three kinds of coal, listing them from the softest to the hardest.

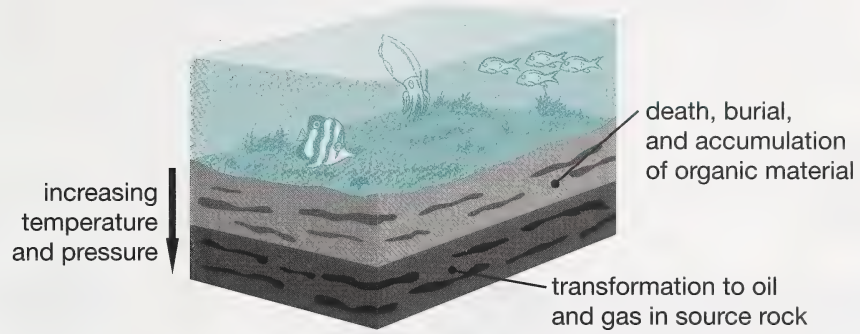
   b. How are the harder types of coal formed?

Check your answers on page 155 of the Appendix.

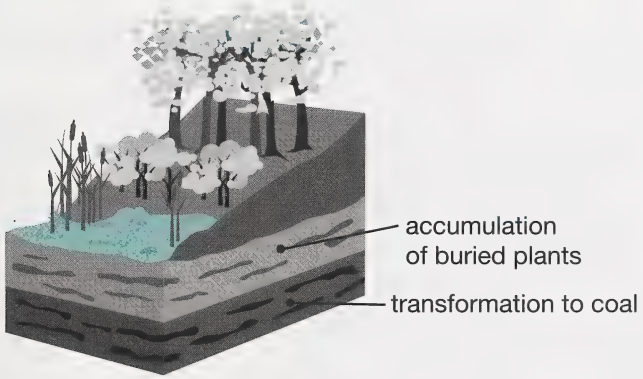


Like coal, oil and natural gas were formed over millions of years. Marine organisms accumulated on the bottom of ancient seas, were covered by sediment, and, through heat and pressure, transformed into oil and gas. Lower temperatures led to oil, and higher temperatures led to natural gas.

Formation of Oil and Natural Gas



Formation of Coal



6. Study the preceding diagrams. What is the main difference in the formation of coal from that of oil and natural gas?

Check your answer on page 155 of the Appendix.

Now, read "The Use of Coal, Oil, and Natural Gas" on page 137 of the textbook.

7. Answer the question posed in "Reading Check" at the bottom of the page.

8. What is petroleum?

9. What did First Nations peoples in southern Alberta use oil for?

Check your answers on page 155 of the Appendix.

Go to page 4 and 5 of Assignment Booklet 2B and answer questions 1 to 5.

Lesson 2

Extracting Coal, Oil, and Natural Gas

A pump jack is a familiar sight on the Alberta landscape. Have you wondered how geologists know where and how deep to drill to find oil and natural gas? Do you know the principle refineries use to extract the gasoline for your car or diesel for trucks from raw crude? What about natural gas for homes and industry? Can it be refined or separated to obtain other products?

And then there is coal. Why is some coal mined far underground and some near the surface? What role, if any, does coal have in a modern society?

These are some of the questions you will find answers to in this lesson.

Turn to page 138 of the textbook and read the introduction to "Extracting Coal and Oil." Then read "Mining Coal" on pages 138 and 139. Study Figure 8.5 closely.

1. Answer the question posed in "Reading Check" on the left side of page 138 of the textbook.

2. Give two reasons why open-pit coal mines are the principal sources of western Canadian coal.

3. Why is open-pit mining so destructive?

4. What are the four steps used to reclaim the land in open-pit mines?

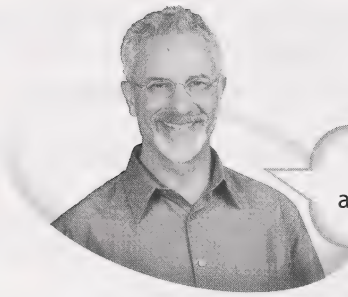
Check your answers on pages 155 and 156 of the Appendix.

Did you know?

About 95% of Canada's coal is extracted from open-pit mines in western Canada. The remaining 5% is extracted from deep mines in Atlantic Canada. Draglines, like the one shown in the photograph, are used to obtain coal from open-pit mines.

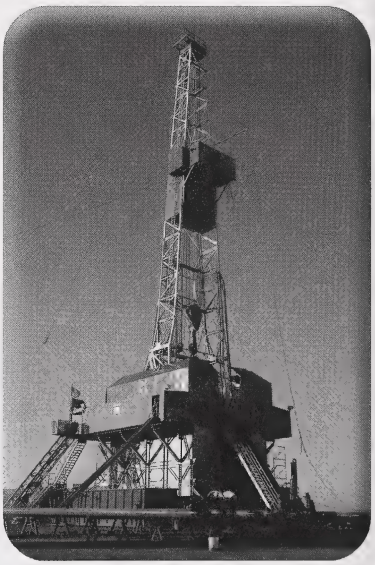
To find out more about coal recovery in western Canada, visit the following website:

http://interactive.usask.ca/ski/mining/search/mineral_types/energy/coal.html



Next, you will investigate how geologists locate oil and natural gas trapped deep below Earth's surface.

Turn to pages 139 and 140 of the textbook and read "Oil" and "Searching for Oil."



5. Where and when was oil first discovered in Alberta?

6. What is meant by impermeable rock?

7. Study the diagram at the top of page 140 of the textbook.

   a. State which substance each of wells A, B, C, D, and E would get.

   b. What colour is the porous rock layer?

8. What is the name for the rock where natural gas, oil, and water are trapped?

9. Why does water form the bottom-most layer below oil and natural gas?

10. Answer the question posed in the "Reading Check" on page 140 of the textbook.

CHECK

Check your answers on page 156 of the Appendix.

Huge oil reserves are locked in the Athabasca Oil Sands, which cover about 40 000 km^2 in the Fort McMurray area. The Athabasca Oil Sands represent the largest non-conventional oil reserves in the world.

SUNCOR ENERGY INC.

To find out more about the oil sands and how the oil is extracted, complete "Internet Connect" on page 139 of the textbook. You may also find information on the Athabasca Oil Sands at your local library.

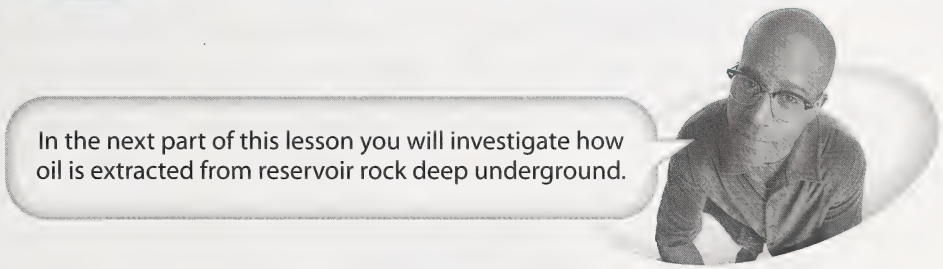
11. What is the estimated reserves in the Athabasca Oil Sands?

12. Explain how the oil sands originated.

13. How are the oil sands mined?

14. How is the oil recovered from the sands?

Check your answers on pages 156 and 157 of the Appendix.

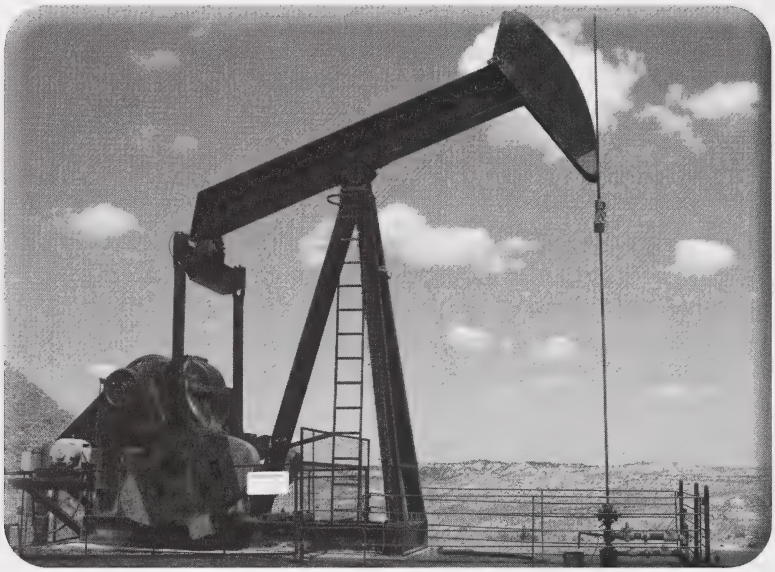


Turn to page 141 of the textbook and read "Drilling for Oil."

15. How can a garden hose with a hand-controlled nozzle be compared to an oil well?

16. Answer the question in "Reading Check."

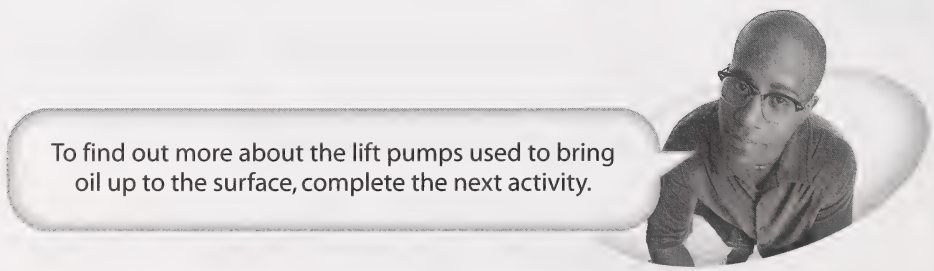
Check your answers on page 157 of the Appendix.



The traditional "horsehead" pump jacks you see scattered all over Alberta convert the rotary power of a gasoline, diesel, or electric motor into reciprocating (up and down) motion. The rod you see attached to the head extends into the well pipe and may be attached to additional rods and then to a reciprocating or lift pump. This lift pump is identical in principle to water-well lift pumps that have been around since their invention about 2200 years ago.

Oil wells may be drilled to depths of many hundreds of metres. But the oil reservoirs they tap are capped by natural gas and "float" on water. The pressures the natural gas and water exert force the oil up the well pipe almost to the surface, and in some cases even higher! The oil then can be extracted using lift pumps.

There are other kinds of pumps if the oil is too thick, if it doesn't rise high enough so lift pumps can be used, or if it contains too much sand that can plug lift pump valves. One such pump is the progressive cavity pump that works much like a grain auger.



Find Out Activity

Model Lift Pump

Read the entire activity on page 141 of the textbook.

If you have access to the materials, do **Part A**. If you do not have access to the materials, do **Part B**.

Part A

Complete the steps outlined in "What to Do." **Pay special attention to the safety precautions mentioned.**

17. Answer questions 1 and 2 of "What Did You Find Out?"

CHECK

Check your answers on page 157 of the Appendix.

Part B

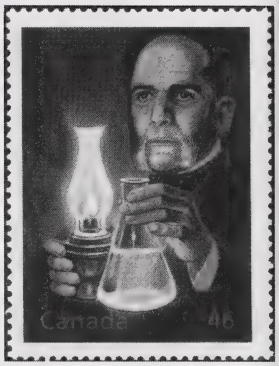
Go to the following website:

http://www.geocities.com/athens/acropolis/6914/pppe.htm

View the "Lift Pump" animation. Use the lift pump model in the animation to answer question 17 in Part A. You can also research lift pumps at your local library.

Did you know?

Refineries and petrochemical plants are symbols of modern society and its dependence on fossil fuels. It was a Canadian medical doctor and geologist by the name of Abraham Gesner who pioneered refining kerosene from crude oil.



Abraham Gesner (1797–1864)

If you have access to the Internet, you can find out more about this petrochemical pioneer at

http://museum.gov.ns.ca/fossils/finders/gesner.htm

You may also be able to find information on Abraham Gesner at your local library.

Turn to page 143 of the textbook and read "Refining Oil."

18. Describe the distillation process used in refineries.

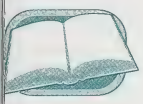
Check your answer on page 157 of the Appendix.

[1] © Canada Post Corporation, 2000. Reproduced with permission.

To further explore the distillation process in refining petroleum, complete the following activity.

Find Out Activity

Distilling a Soft Drink



Read the entire activity on page 142 of the textbook.

If you have access to a supervised laboratory, do **Part A**. If you do not have access to a supervised laboratory or if your laboratory does not have all the necessary equipment, do **Part B**.

Part A

Follow the steps in "What to Do" carefully to complete the investigation. **Pay special attention to the safety precautions mentioned.**

19. Answer questions 1 to 5 of "What Did You Find Out?"

Check your answers on pages 157 and 158 of the Appendix.

Part B

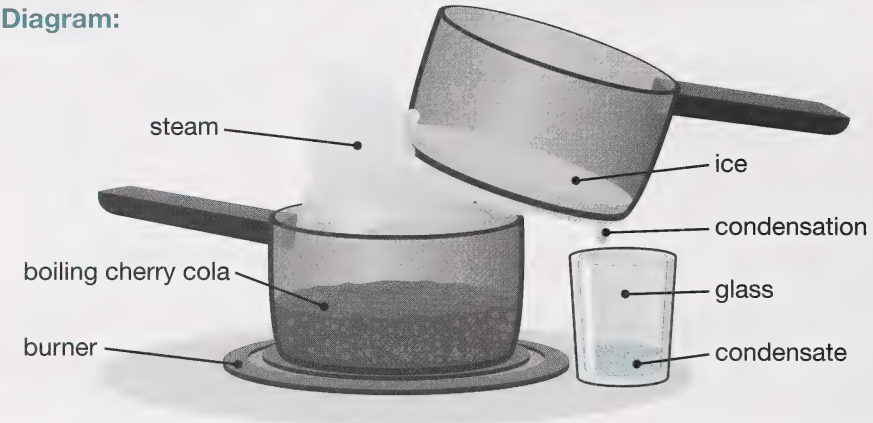
The following activity is similar to the one in Part A. This activity, however, uses materials and apparatus that are available at home.

Purpose: to investigate the distillation of a soft drink

Materials and Apparatus:

- 250 ml of cherry-flavoured cola
- 2 steel cooking pots with handles
- candy thermometer
- glass container
- stove

Diagram:



Procedure:

step 1: Pour water to a depth of about 2 cm into one of the pots. Place the pot in the freezer (or outside if you are doing this on a cold, winter day). Wait until the water is completely frozen.

step 2: Pour 250 mL of the soft drink into the second pot, and place it on a burner on your stove. Heat the pot on low to medium heat until it comes to a gentle boil. Reduce the heat if necessary, and maintain the gentle boil. **Caution: Remove the pot from the burner if there is any risk of the soft drink boiling over!**

step 3: Place the candy thermometer into the boiling liquid. Do not let the thermometer touch the sides or the bottom of the pot. Record the temperature of the boiling soft drink. Then remove the thermometer and set it aside.

step 4: Place the bottom of the first pot over, but not covering, the top of the pot on the stove. Hold the handle of the pot with the ice so that it is at a slight angle, allowing any condensation that forms on the bottom to drip into a glass container.

step 5: Stop once you have collected 2–3 mL of condensate.

Observation:

20. How does the liquid you collected differ from the soft drink?

21. Answer questions 1 to 5 of "What Did You Find Out?"

Check your answers on page 158 of the Appendix.

Distillation is used in refining crude oil. If you have access to the Internet, research how petroleum is distilled to obtain a wide range of products. You may also research petroleum distillation at your local library.

Now, turn to page 143 of the textbook and read "Natural Gas."

22. How is natural gas transported to homes and industry?

23. Why is natural gas a popular fuel?

Check your answers on page 158 of the Appendix.

You should now have a good understanding of how fossil fuels are extracted and used to enhance people's lives. Answer the following questions to review what you covered.

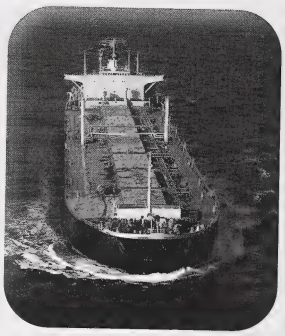
24. Answer questions 3, 4, and 5 of "Check Your Understanding" on page 143 of the textbook.

Check your answers on page 158 of the Appendix.

Go to pages 5 and 6 of Assignment Booklet 2B and answer questions 6 to 10.

Lesson 3

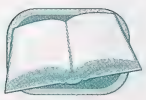
Combustion



combustion: the burning of a fuel in oxygen

Internal **combustion** engines have dramatically changed people's lives over the last century. The controlled burning of fossil fuels—including gasoline, diesel, propane, or natural gas—in these engines has provided cheap, reliable transportation on land, air, and sea. Over the years, these engines have been refined and made more efficient, converting more of the stored chemical energy in the fuels they burn into useful output energy.

In this lesson you will explore the combustion of fossil fuels to produce and harness thermal energy.



Turn to page 144 of the textbook. Read the opening discussion in "Combustion."

1. What is combustion?

2. Why are fossil fuels called hydrocarbons?

3. What are the reactants in a hydrocarbon combustion? What are the products?

4. Why is it dangerous to use an unvented propane heater indoors?

Check your answers on page 159 of the Appendix.

In the following investigation, you will explore a hydrocarbon combustion reaction.

Investigation

8-A: Examining Combustion

Read through the entire investigation on page 145 of the textbook.

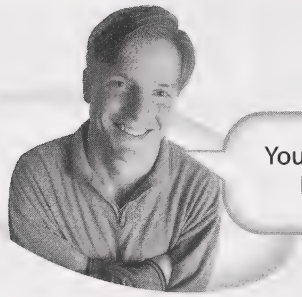
You will design and carry out an investigation to provide four pieces of evidence that a combustion reaction occurs when a candle burns. **Include any additional safety precautions in your design.** If you are working at home or do not have access to the stated materials, you can use tin cans and jar tongs in place of the beakers. Be sure the tin cans you use are not lined with plastic.

5. Complete a lab report for this investigation. Use the template provided at the back of the Appendix.

6. In Section 3: Lesson 1 you investigated cellular respiration—a reaction similar to combustion involving glucose and oxygen. The carbohydrate glucose is like a hydrocarbon because it contains hydrogen and carbon. What element in addition to hydrogen and carbon does glucose contain?

CHECK

Check your answers on pages 159 to 161 of the Appendix.



You will now explore the similarities and differences between combustion and cellular respiration.

Turn to page 146 in the textbook and study the discussion in "Combustion and Cellular Respiration."

7. Complete questions 1, 2, and 3 posed in the reading on page 146 of the textbook.

CHECK Check your answers on page 161 of the Appendix.

You should now have a good understanding of the combustion of fossil fuels. To review what you covered, answer the following questions.

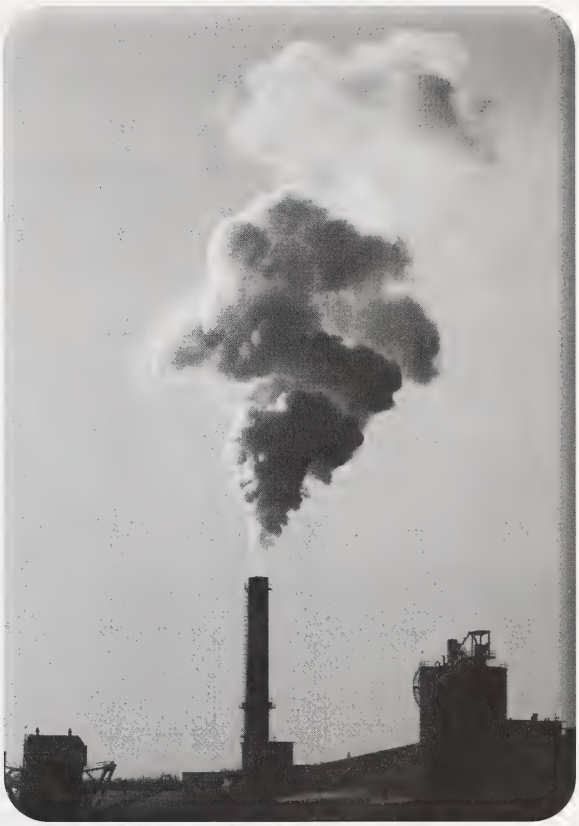
8. Answer questions 1, 2, and 3 of "Check Your Understanding" on page 146 of the textbook.

CHECK Check your answers on page 161 of the Appendix.

Go to ... Go to page 7 of Assignment Booklet 2B and answer questions 11 to 14.

Lesson 4

The Other Side of the Coin



On a cold, winter day if you look at a factory smokestack, a chimney, or automobile exhaust, you will see the condensation of water vapour—one of the products of fossil fuel combustion. Unfortunately, there are other compounds released into the atmosphere:

- carbon dioxide, which may contribute to climate change and global warming
- sulfur oxides and nitrogen oxides, which react with water in the air to produce acid precipitation
- carbon monoxide, which is a colourless, odourless, deadly gas

Climate change and pollution that poisons air, soil, and water aren't the only problems that arise through people's dependence on fossil fuels. Oil spills on land and at sea endanger wildlife; and plastics made from hydrocarbons litter the landscape and take up landfill space.

In this lesson, you will explore this other side of society's dependence on fossil fuels. You will determine what you can do to conserve these valuable and diminishing resources and protect the environment at the same time.

Turn to page 147 of the textbook and read the introduction to "The Other Side of the Coin."

1. Why are fossil fuels termed *non-renewable resources*?

2. What happens to nearby marine life when an oil tanker runs aground or leaks oil?

Check your answers on page 162 of the Appendix.

One of the worst oil spills off the west coast of North America occurred in March 1989. The *Exxon Valdez* ran aground and spilled over 40 million litres of oil into the ecologically sensitive Prince William Sound off the coast of Alaska. In the photograph, you see workers using high-pressure, hot-water hoses to clean oil from the shore.

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

Workers clean the shoreline after the *Exxon Valdez* oil spill.

If you have access to the Internet, you can find out more about this spill, efforts to clean it up, and the long-term consequences on wildlife and the environment at the following website:

http://response.restoration.noaa.gov/spotlight/spotlight.html

Another huge spill, almost twice as large as the *Exxon Valdez*, occurred in November 2002 off the coast of Spain. The tanker *Prestige* broke up, releasing over 60 000 tonnes of oil into the Atlantic. This spill had the potential to be one of the worst environmental disasters in modern Europe's history. However, only 2 million gallons (about 10% of its load) were spilled onto the surface of the ocean. The rest went down to the bottom of the ocean with the tanker. There were discussions about how the oil could be recovered from the bottom of the ocean, but the recovery would be extremely challenging if at all possible.

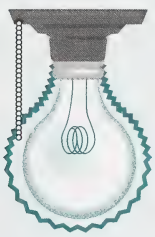
To research this spill, you can access numerous websites. Here is one such website:

http://earth.esa.int/ew/oil_slicks/galicia_sp_02/_os_galicia2_nov_02.html

Another major concern is the increasing world demand for fossil fuels and a diminishing supply. In the next investigation you will explore some of the details of this issue.

Investigation

8-B: World Energy Consumption



Read the entire investigation on page 148 of the textbook.

3. Draw the line graph as outlined in "What to Do."
4. Answer questions 1 to 4 of "Analyze."

CHECK Check your answers on pages 162 and 163 of the Appendix.

In the last part of this lesson you will explore reasons why the world needs to limit its fossil fuel consumption.

Turn to pages 148 and 149 of the textbook and read "More Reasons to Reduce Fuel Consumption" and "Greenhouse Gas."

5. Explain the origin of acid deposition.

6. How does acid deposition affect lakes and streams?

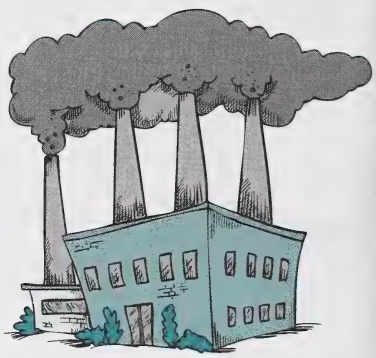
7. What is the greenhouse effect?

8. How does the burning of fossil fuels contribute to the greenhouse effect and global climate change?

9. What is some of the evidence to support concerns about global climate change?

Check your answers on page 163 of the Appendix.

Did you know?



Did you know that until the beginning of the 19th century and the Industrial Revolution, one of the main greenhouse gases, carbon dioxide, had remained essentially the same for 10 000 years? Since 1800, the amount of carbon dioxide in the atmosphere has increased by approximately 30%. And, at current rates of fossil fuel consumption, the amount of carbon dioxide could double from pre-1800 levels. A panel of 2000 of the world's foremost climatologists predict that Earth's average temperature could increase between 1.4°C and 5.8°C by 2100. Even small changes in global temperature can produce disastrous effects.

Canada has supported the Kyoto Protocol, an international agreement among industrial nations to reduce greenhouse gases. Under the Protocol, Canada has committed to reducing its greenhouse gas emissions to 6% below 1990 levels.

If you have access to the Internet, find out more about Canada's climate change plan at the following website:

http://www.climatechange.gc.ca/plan_for_canada/plan/chap_1.html

10. List five things you and your family can do to reduce greenhouse gases.

Check your answer on page 163 of the Appendix.

You should now have a good understanding of the problems associated with fossil fuels. To review these issues, answer the following questions. You may also want to complete the activity outlined in "Internet Connect" on page 149 of the textbook.

11. Answer questions 1 and 2 of "Check Your Understanding" on page 149 of the textbook.

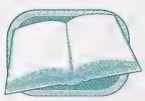
Check your answers on page 164 of the Appendix.

Go to page 8 of Assignment Booklet 2B and answer questions 15 to 18.

Section 4 Review

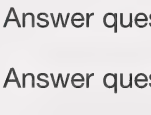
In this section, you investigated fossil fuels. You explored how coal, oil, and natural gas formed millions of years ago; how geologists determine where they are located; and how they are extracted. In particular, you examined how oil is pumped from wells, transported, and refined. You then explored the combustion of fossil fuels and how combustion and cellular respiration are related. Modern society is dependent on fossil fuels as a cheap and available source of energy and for a whole host of products few people are prepared to live without. You addressed issues of supply and conservation, and you explored problems of pollution and global climate change associated with extracting, transporting, and burning fossil fuels.

The industrialization of the world has led to increased energy use and pollution. Increasing pollution and global climate change is still a major concern. The Kyoto Protocol is an attempt by a number of industrial countries to reduce greenhouse gases and, thus, reduce the threat of climate change. What are your thoughts on the benefits of the Kyoto Protocol?



You have now completed the concepts for this section. To review what you studied, do the following "Chapter 8 Review" questions on pages 150 and 151 of the textbook. If necessary, go back and read over parts of this section as you answer the questions.

1. Answer question 1 of "Reviewing Key Terms."
2. Answer questions 3, 4, and 6 of "Understanding Key Ideas."
3. Answer questions 9 and 10 of "Developing Skills."
4. Answer questions 12 and 13 of "Problem Solving/Applying."



Check your answers on pages 164 and 165 of the Appendix.

Module Summary

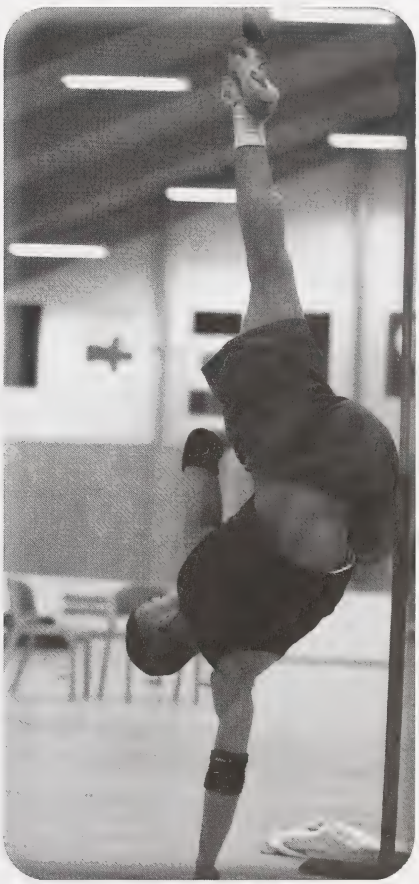
In this module you investigated and described energy transformations.

In Section 1 you identified different types of energy and examined how one form of energy is converted into another. You learned about the Law of Conservation of Energy and discovered that energy is not lost when it is changed from one form to another.

In Section 2 you explored the different ways of generating electric energy and how electric energy is transmitted, measured, and sold. You also investigated efficiency with electric energy and how electric energy can be saved.

In Section 3 you investigated nature's conversion—how energy is captured by green plants and converted into energy your body can use. You compared the energy conversion of photosynthesis to cellular respiration. You investigated human need for energy and identified various sources of energy for humans.

In Section 4 you defined fossil fuels and identified various types of fossil fuels. You examined ways of extracting fossil fuels and how they are converted into useable fuels. You identified criteria for combustion and compared combustion to cellular respiration. You anaylzed world energy consumption and identified some problems associated with continuing fossil fuel use.

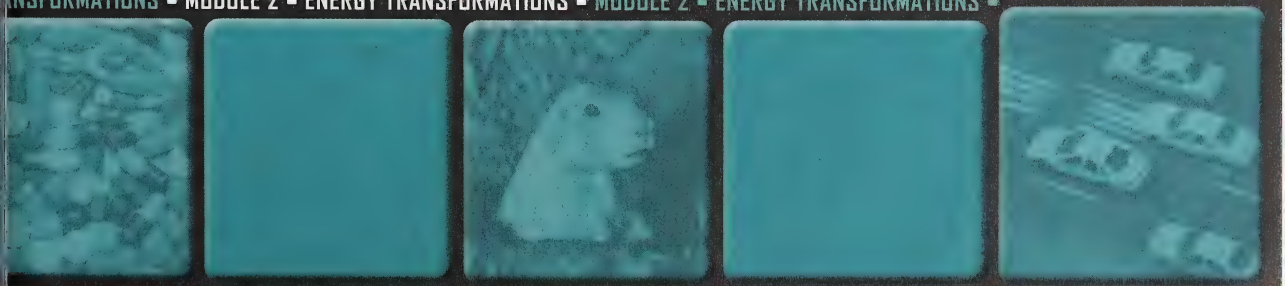


DEREK CROWE PHOTOGRAPHY/ARCTIC WINTER GAMES

Examine the photo of the athlete competing in the high kick event at the Arctic Winter Games in 2003. How many energy transformations can you identify? Certainly the conversion of chemical potential energy of glucose through the athlete's muscles into kinetic energy and heat is one. Another is the electric energy converted into light and heat in the gymnasium. There are lots more! Can you find them?

APPENDIX

GLOSSARY ■ SUGGESTED ANSWERS ■ IMAGE CREDITS



Glossary

acid deposition: acidic material, both solid and liquid, deposited on Earth

Benedict's solution: a blue solution used to test for simple reducing sugars

calorie: a unit of energy

carbohydrates: foods consisting of compounds of carbon, hydrogen, and oxygen; main source of energy for the body

cellular respiration: a process used by all plant and animal cells to obtain energy from food

chemical energy: energy stored in compounds

chlorophyll: a green-coloured chemical that assists photosynthesis

chloroplasts: cell parts that capture solar energy and convert it into energy plants can use

combustion: the burning of a fuel in oxygen

converter: a system where energy is changed from one form to another

crude oil: oil directly obtained from Earth's interior

distillation: a process by which a substance is separated into its components by boiling and then condensing the vapours

ecological pyramid: a pyramid showing that it takes many organisms at lower levels to support fewer and fewer organisms at higher levels

efficiency: a measure of how much input energy is converted into useful output energy

energy: the ability to do work

fat: a nutrient that is a rich source of energy for the body

fossil fuel: a fuel formed from the remains of organisms that lived millions of years ago

e.g., coal, oil, and natural gas

galvanometer: a device that detects and measures electric current

generator: a device that converts kinetic energy into electric energy

geothermal energy: a source of thermal energy from Earth's interior

glucose: a form of sugar that can be utilized by the cell

glycogen: a starch-like substance glucose is converted into when it is not needed for immediate energy needs

gravitational energy: energy dependent on the position of an object in a gravitational field

greenhouse effect: the trapping of thermal energy by Earth's atmosphere

greenhouse gas: a gas that contributes to the greenhouse effect

e.g., carbon dioxide

heat: the flow of energy from one object to another

homeostasis: a steady state

hydrocarbon: a compound of hydrogen and carbon

hydro-electric power: power generated from the kinetic energy of falling water

input energy: energy that enters a system

joule (J): a unit of energy and work (1 J = 1 N•m)

kinetic energy: energy of motion

Law of Conservation of Energy: a law stating that energy cannot be created nor destroyed

lift pump: a pump that uses a system of valves and air pressure to lift a liquid

mechanical kinetic energy: energy involving the motion of objects

mechanical potential energy: energy stored in an object as the result of work being done

metabolism: the rate at which a body uses energy

methane: a major component of natural gas

mitochondria: a cell part where cellular respiration occurs

newton (N): a unit of force

output energy: energy that leaves a system

photosynthesis: a process in green plants that converts carbon dioxide and water into glucose and oxygen

potential energy: stored energy

power: the rate of doing work

primary consumer: an animal that obtains its energy by eating producers (e.g. green plants)

progressive cavity pump: a pump that uses a rotating screw to lift liquids

propane: a gas obtained from natural gas

protein: building block and source of energy for the body

pump jack: a device that converts the rotary motion of a motor into reciprocating motion to drive a pump

reservoir rock: porous rock in which oil, water, and natural gas collects

saturated fat: fat from animals and some plants

secondary consumer: an animal that obtains its energy by eating primary consumers

seismic survey: a means of using shock waves to obtain an image of the layers of rock below Earth's surface

solar cell: a device that converts solar energy into electric energy

solar energy: energy from the Sun

thermal-electric power: power generated using the thermal energy created when burning fossil fuels

thermal energy: the sum of all the kinetic energies of all the particles of a substance (heat)

turbine: a set of spinning blades that collect energy from wind, steam, or water

unsaturated fat: fat from most vegetable oils

voltmeter: a device that measures electric potential

watt (W): a unit of power (1 W = 1 J/s)

wind energy: energy from the wind

work: a force acting through a distance ($W = F \times d$)

Suggested Answers

Section 1: Lesson 1

1. The pendulum almost returns to its original position as it swings back and forth. It gradually loses energy through friction and air resistance.

2. The pendulum has its greatest potential energy at its highest point, just before it is released.

3. The pendulum has its greatest kinetic energy at its lowest point, when the supporting string is vertical.

4. a. The mass almost returns to the point of release.

   b. You should position your head against the wall so you don't move forward into the pendulum as it swings toward you.

5. a. kinetic energy

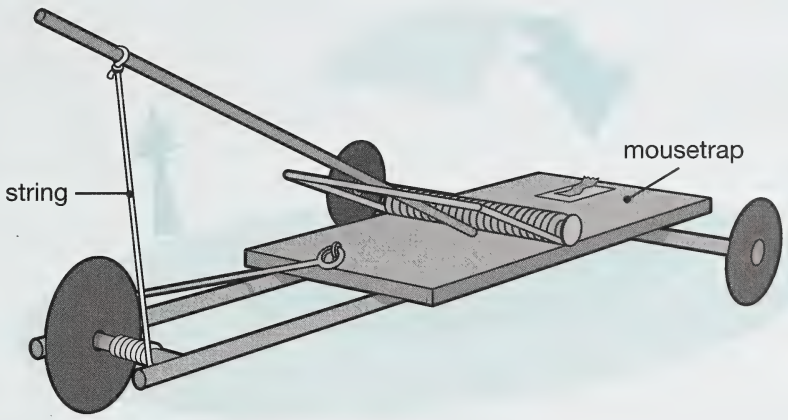
   b. potential energy

   c. potential energy

   d. kinetic energy

6. **Textbook questions 1 and 2 of "Plan and Construct," p. 83**

1. Sketches will vary. A sample sketch of a mousetrap car is given.



2. a. The release of the spring converts potential energy into kinetic energy.

   b. As the spring (the trap itself) is released, the potential energy is converted into kinetic energy, rotating the wheels and moving the car forward.

7. **Textbook questions 1 and 2 of "Check Your Understanding," p. 83**

1. *Potential energy* is stored energy that can be converted into other forms of energy. Examples of potential energy include gravitational potential energy, chemical potential energy stored in glucose, and the potential energy stored in a stretched elastic band or compressed spring.

   Kinetic energy is energy due to motion. Examples of kinetic energy include the energy of a fly ball, a moving car, and a skier racing down a hill.

2. Answers will vary. Sample answers are given.

   a. When you are walking to school, you depend on the chemical energy stored in glucose in your muscles and the kinetic energy of moving your muscles.

   b. When you are driving to the store, you depend on the chemical energy stored in the gasoline and the kinetic energies of moving parts and of the vehicle itself. You also depend on chemical energy stored in glucose to move your muscles so you can press the accelerator and brake and turn the steering wheel.

c. When you are turning on a computer, you depend on the chemical energy stored in glucose converting into kinetic energy of moving your muscles to flip the switch. You also depend on electric energy from the outlet, kinetic energy of the hard drive, and light energy from the monitor.

d. When you are listening to the radio, you depend on electric energy, kinetic energy of the speaker, sound energy, the kinetic energy of your eardrum and inner ear, and the electric energy of your nerve impulses to your brain.

Section 1: Lesson 2

1. a. The potential energy of a bow is a maximum when the string is drawn back to the full position before it is released. The kinetic energy is zero at this point.

   b. The kinetic energy of the arrow is a maximum immediately after the arrow leaves the string. The potential energy of the bow is zero at this point.

2. a. Sunlight is electromagnetic or radiant energy. It is commonly called solar energy.

   b. The energy of a rotating wheel is mechanical kinetic energy.

   c. The energy produced by a speaker is sound energy.

   d. The energy of a glass of hot chocolate is thermal energy (heat).

   e. The energy stored in a woodpile is chemical potential energy.

3. Answers will vary. Sample answers are given.

   Sources of energy include windmills, geothermal activity, solar panels, thermo-electric plants, fossil fuels, plants, and the campfire.

4. **Textbook questions 1, 2 and 3 of "Check Your Understanding," p. 85**

   1. The Sun's energy is converted into chemical potential energy through green plants, into electric energy by solar panels and windmills, and into energy of motion of the deer through the plants they eat.

   2. Thermal energy is a form of kinetic energy because it is due to the motion of the particles in a substance.

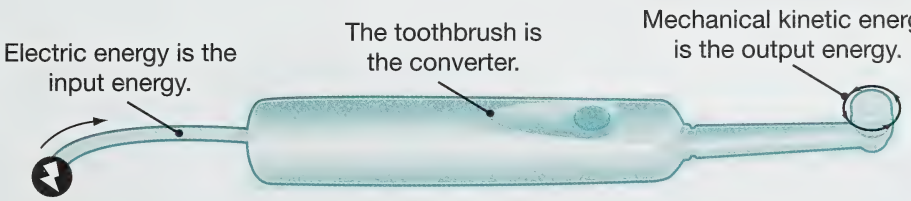
3. Answers will vary. A sample answer is given.

   Chemical energy, previously stored as glucose, is converted by muscles into mechanical kinetic energy to eat the apple. The chemical energy in the apple is stored as glucose to be used by the muscles later to throw a ball, giving the ball kinetic energy.

Section 1: Lesson 3

1. The input energy is electric energy (battery). The converter is the flashlight bulb. The output energy is light and heat.

2. Answers will vary. A sample answer is given.



3. The input energy is the chemical potential energy in the glucose in Paul Tracy's muscles. The converter is Paul Tracy's muscles. The output energy is the kinetic energy of raising the cup over his head and heat energy in the muscles.

4. Potential chemical energy from food is converted into kinetic energy for muscle movement and heat energy.

5. Hot and cold packs contain chemical potential energy.

6. When you kick a ball, you convert the chemical potential energy of glucose in your muscles into the kinetic energy of the kick. This, in turn, transfers kinetic energy to the ball. A by-product of the chemical potential energy conversion into kinetic energy is thermal energy. When you exercise, your muscles produce heat.

7. **Textbooks questions 1 and 2 of "Prediction," p. 88**

   1. The temperature will rise in each case.

   2. A temperature change indicates an energy conversion because of the generation or absorption of heat.

8. Answers will vary. Sample answers are given.

	Before Adding Baking Soda	After Adding Baking Soda
Mass of Cup and Acid	33.26 g	N/A
Mass of Baking Soda	10.23 g	N/A
Total Mass	43.49 g	41.30 g
Temperature	22°C	11°C

9. Your table should be similar to the following.

	Before Adding Magnesium	After Adding Magnesium
Mass of Cup and Acid	33.23 g	N/A
Mass of Magnesium	0.05 g	N/A
Total Mass	33.28 g	33.07 g
Temperature	22°C	28°C

10. a. **Textbook questions 1 to 4 of "Analyze," p. 89**

    1. For citric acid and baking soda, the temperature fell 11°C. For hydrochloric acid and magnesium, the temperature rose 6°C.

    2. a. Both reactions demonstrated an energy conversion by producing or losing heat. The change in temperature indicated lost or gained heat.

       b. The citric acid and baking soda reaction absorbed thermal energy. You know this because the temperature of the mixture dropped.

          The hydrochloric acid and magnesium reaction generated heat. You know this because the temperature of the mixture rose.

3. Evidence that the citric acid and baking soda experiment resulted in a chemical reaction was the production of a gas (bubbles appeared), the "disappearance" of the baking soda, and the decrease in temperature.

   Evidence that the hydrochloric acid and magnesium experiment involved a chemical reaction was the production of a gas (bubbles appeared), the "disappearance" of the magnesium, and the increase in temperature.

4. In each reaction, there was a transfer of energy. For the citric acid and baking soda reaction, heat was transferred from the environment into the products of the reaction. For the hydrochloric acid and magnesium reaction, heat was transferred to the environment from the components of the reaction.

b. **Textbook question 5 of "Conclude and Apply," p. 89**

5. A change of mass occurred because some gas was produced and escaped. The change in Part 1: Mass for Citric Acid and Baking Soda was 2.19 g (43.49 g – 41.30 g). The change in mass for Part 2: Hydrochloric Acid and Magnesium was 0.21 g (33.28 g – 33.07 g).

11.

The Converter	Input Energy	Output Energy	Is Thermal Energy Given Off?
flashlight bulb	*chemical energy (battery)*	*light energy (bulb)*	*yes*
snowblower engine	chemical energy (gasoline)	kinetic energy	yes
person paddling	chemical energy (glucose)	kinetic energy	yes
drill press	electric energy	kinetic energy	yes
rocket	chemical energy	kinetic energy	yes
person trampolining	chemical energy	kinetic energy	yes
person eating	kinetic energy	chemical energy	yes

12. **Textbook questions 1 and 2 of "Analyze," p. 90**

    1. Kinetic energy is more common than others in these examples. Machines and activities involve an output of kinetic energy.

    2. For the snowblower, paddler, drill press, rocket, and person trampolining, thermal energy could be considered to be wasted energy because kinetic energy is the desired output.

13. The chemical potential energy in the munitions were converted into thermal energy, light energy, sound energy, and kinetic energy of the blast.

14. **Textbook questions 1, 2, and 3 of "Check Your Understanding," p. 91**

    1. Input energy, a converter, and output energy are necessary for an energy conversion.

    2. Solar energy strikes the exterior of the car and passes through the windows. The surfaces inside the vehicle absorb some of this energy and convert it into thermal energy. Some of this thermal energy heats the air inside the car. Since the air is trapped inside the car, thermal energy coming into the car heats the air over and over.

    3. Answers will vary. Sample answers are given.

        - Heat is produced when coal is burned.
        - Heat is produced through friction from kinetic energy when sandpaper is rubbed on a surface.
        - Heat is produced when water tumbles down a waterfall, converting potential energy into kinetic energy.
        - Heat is produced by a light bulb when electric energy is converted into light energy.

Section 1: Lesson 4

1. The input energy of a hair dryer is electric energy.

2. The output energy includes mechanical kinetic energy, sound energy, light energy, thermal energy, and wasted heat.

3. The Law of Conservation of Energy states that the input energy is equal to the output energy.

4. **Textbook questions 1 to 5 of "What Did You Find Out?," p. 93**

    1. The second pendulum began to swing in larger and larger arcs after the first pendulum was released.

    2. The first pendulum swung in smaller and smaller arcs as the second pendulum began swinging in larger arcs.

    3. Eventually, the first pendulum stopped momentarily when the second pendulum was swinging through an arc that appeared to be as large as the arc of the first pendulum just as it was released. Then the situation reversed, with the first pendulum picking up energy as the second pendulum lost energy.

    4. As one pendulum lost energy, the other pendulum picked up energy. The total energy of the two pendulums remained the same except for what was lost to friction of the string. The Law of Conservation of Energy was demonstrated in this activity by the total energy remaining constant.

    5. a. The pendulum had its greatest potential energy when it reached its maximum height.

        b. The pendulum had its greatest kinetic energy when it passed through the lowest point of its arc.

5. **Textbook question 2 of "Check Your Understanding," p. 93**

    2. Most of the energy produced by a car's engine is wasted heat from the combustion of the fuel in the cylinders and from the friction of the mechanical parts.

Section 1: Lesson 5

1. input energy = useful output energy + waste output energy

2. Waste energies produced by a gasoline lawn mower include thermal energy (heat) transferred from the burning fuel, sound energy (engine noise), and thermal energy (heat) lost due to friction of moving parts.

3. **Textbook questions 1 to 4 of "Evaluate," p. 95**

    1. Maintain a clean work area free of hazards. Use a fan that has a safe wire cage over the blades.

2. The electric fan converts electric energy into mechanical kinetic energy of the blades. The blades, in turn, transfer kinetic energy to move the air. The windmill converts the kinetic energy of the moving air into mechanical kinetic energy of the rotating wings of the windmill.

3. a. Answers will depend on your design. You may make larger or smaller blades or move the windmill closer to the fan.

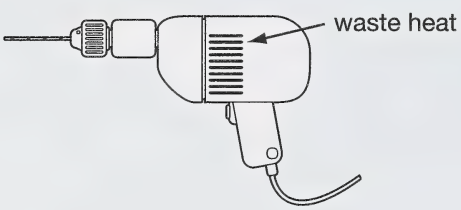
   b. You could make a cone from construction paper to hold in front of the blades of the fan to concentrate the energy of the moving air toward the fan. You could also lubricate your axle with soap, silicon, or mineral oil.

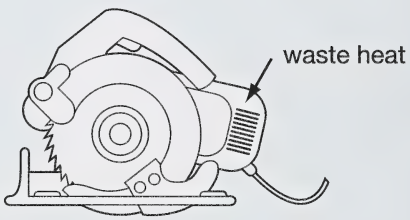
4. a. Input was wasted in the fan's production of heat and sound, and much of the moving air blew past the windmill.

   b. Concentrate the energy of the fan towards the windmill. Turn your windmill so it is facing the moving air. Change the design of the blades on your windmill.

4. **Textbook question 2 of "Check Your Understanding," p. 95**

2. Answers will vary. Sample answers are given. Examples could also include engines that burn fuel and moving parts that produce friction.





Section 1 Review

1. a. An apple hanging in a tree and water behind a dam are the two examples of potential energy given in the introduction.

   b. The potential energy is transformed into kinetic energy when the apple falls and when the water behind the dam is released.

   c. The kinetic energy of the moving baseball is transformed into thermal energy and sound energy when it stops in the baseball mitt.

d. The amount of potential energy of the apple is equal to the amount of kinetic energy.

e. The total energy remains the same as the apple falls.

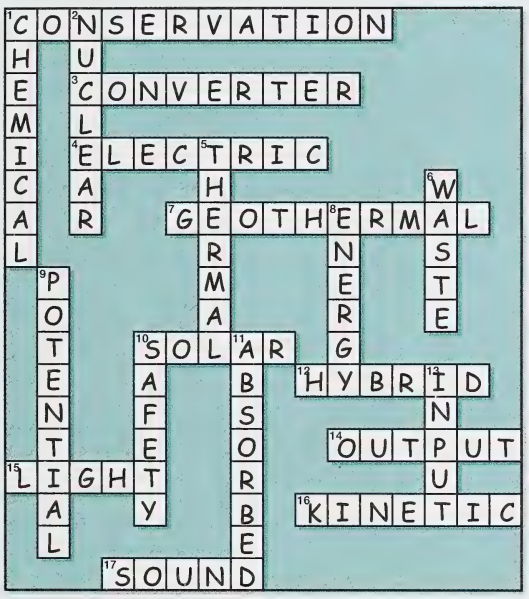
f. The source of energy for many energy transformations is the Sun.

g. Cellular respiration transforms **chemical** energy into **kinetic** energy (Part 4).

h. The soccer ball finally stops because all its initial kinetic energy is transformed into other types of energy, such as thermal energy and sound energy.

i. Photosynthesis transforms solar energy into potential chemical energy.

2.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17 S O U N D

3. a. **Textbook questions 2 and 3 of "Understanding Key Ideas," p. 96**

2. The student and his bicycle have potential energy when they are above the lowest point on the hill. As he and the bicycle go down the hill, potential energy converts into kinetic energy—the energy of motion. The student and his bicycle have kinetic energy as long as they are moving.

3. Answers will vary. Some converters that capture energy from the Sun are

   - chloroplast in green plants
   - solar panels
   - your skin
   - photovoltaic cells
   - any substance on Earth that converts solar energy into thermal energy (e.g., rock, soil, water, and air)

b. **Textbook questions 5, 6, and 7 of "Developing Skills," p. 97**

5. By reducing waste energy, your machines will run more efficiently. They will convert a higher percentage of input energy into useful output energy. Efficient machines save money and help protect the environment by reducing the demand for energy.

6. Answers will vary. Furnaces, microwave ovens, electric heaters, and hair dryers are some machines that convert input energy into useful thermal energy.

7. The amusement ride converts gravitational potential energy into kinetic energy to create excitement.

c. **Textbook question 8 of "Problem Solving/Applying," p. 97**

8. a. The person playing a guitar converts kinetic energy into sound energy when he or she plucks the guitar strings.

   input energy: chemical energy in glucose through muscles in person's fingers
   converter: strings and body of guitar
   output energy: sound

   The person skateboarding converts the chemical energy in glucose through his or her muscles into kinetic energy.

   input energy: chemical energy in glucose through the person's muscles
   converter: skateboard
   output energy: kinetic energy

   b. In each case, heat and sound energy are lost to the environment.

d. **Textbook question 12 of "Critical Thinking," p. 97**

12. The Law of Conservation of Energy is not wrong. The pendulums stop moving because thermal energy through string friction is lost to the environment.

Section 2: Lesson 1

1. When the magnet is moved in and out of the tube, the needle of the galvanometer moves in one direction (either to the right or left) and then in the opposite direction.

2. **Textbook questions 1 to 4 of "What Did You Discover?," p. 99**

    1. There is movement of the needle in the measuring device.

    2. The direction the needle moves depends on which way the wires are connected. If you switch the wires, the needle will move in the other direction.

    3. The input energy is the motion (kinetic energy) of the magnet through the coil of wire. The converter is the coil of wire. The output energy is electric energy.

    4. Some ways to increase the amount of electric energy generated in this system is to use a stronger magnet or wrap more coils around the tube.

3. When the battery was connected to free ends of the copper wire, the needle of the compass moved from the centre to one side (either to the right or left depending on how the battery was oriented) at right angles to the coil of wire around the compass.

4. When the battery was reversed, the needle of the compass moved to the other side.

5. When the magnet moved in and out of the tube, the needle of the compass moved in one direction (either to the right or left) and then in the opposite direction.

6. Yes, moving the magnet in and out of the tube induced an electric current in the wire. The compass behaved in exactly the same way as when the battery was connected to the copper wire.

7. Refer to the answers to question 2.

8. When the battery was connected to the free ends of the copper wire, the needle inside the coil of copper wire moved from the centre to one side (either to the right or left depending on how the battery was oriented) at right angles to the coil of wire.

9. When the battery was reversed, the needle moved to the other side.

10. When the magnet moved in and out of the tube, the needle moved in one direction (either to the right or left) and then in the opposite direction.

11. Yes, moving the magnet in and out of the tube induced a current in the wire. The needle behaved in exactly the same way as when the battery was connected to the copper wire.

12. Refer to answers to question 2.

13. An electric generator is a device that converts kinetic energy into electric energy.

14. You generated electricity by moving a magnet in and out of coils of copper wire.

15. **Textbook questions 1, 2, and 3 of "What Did You Find Out?," p. 100**

    1. When the number of turns of wire is increased, the deflection of the galvanometer needle or the compass needle is greater.

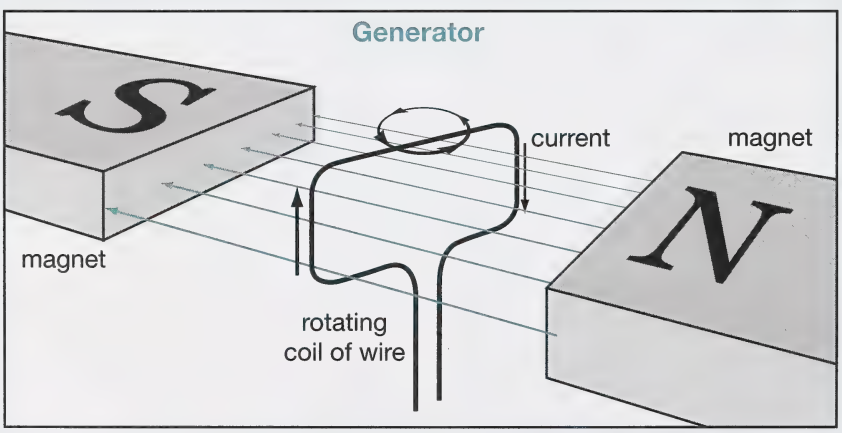
    2. No, it does not matter whether the magnet or the coil moves. An electric current is induced in either case.

    3. You can increase the amount of electricity generated by using a stronger magnet, by increasing the number of coils, or by increasing the speed of the magnet or coil.

16. The input energy is mechanical kinetic energy. The generator is the converter. Electricity is the output energy.

17. **Textbook questions 1, 2, and 3 of "Check Your Understanding," p. 101**

    1.



    2. A simple generator produces electric energy by moving a magnet through a coil or passing a coil through a magnetic field.

    3. To increase the amount of electricity generated, you can increase the number of coils, increase the speed of the magnet or coil, or use a type of wire that is more conductive.

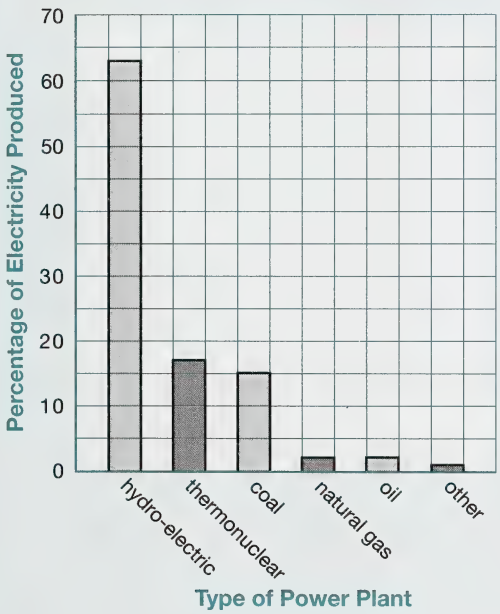
Section 2: Lesson 2

1. A turbine is a set of blades rotating on a shaft that collects energy from the kinetic energy of wind, steam, or water. The turbine is attached to a generator. The kinetic energy of the spinning turbine is transformed into kinetic energy in the generator, which, in turn, generates electricity.

2. **Textbook question "Reading Check," p. 102**

   In Canada electricity is generated in hydro-electric, thermo-electric, and thermonuclear power plants.

3. **Sources for Electric Energy Production in Canada**



4. **Textbook questions 1 to 4 of "Analyze," p. 103**

   1. $63 \div 17 = 3.7$

      Hydro-electric plants in Canada account for approximately 3.7 times more electricity generated than thermonuclear plants.

2. $15 \div 2 = 7.5$

   Coal accounts for 7.5 times more electricity generated than either natural gas or oil. In total, fossil fuels account for about one-fifth of the total power generated in Canada.

3. Natural gas is used less often to generate electricity than coal because natural gas is expensive.

4. Alberta generates so little electricity with hydro-electric stations because it has ample supplies of cheap coal. Also, Alberta has few rivers on which dams can be built.

5. Coal-fired plants are located close to sources of coal to reduce transportation costs.

6. Steam is used to spin the fan blades of the turbines in a coal-fired plant.

7. The generator converts kinetic energy into electric energy.

8. When the steam leaves the turbine, it cools, condenses, and recycles.

9. Disadvantages include the following:

   - The production of carbon dioxide is linked to climate change.
   - The production of sulfur dioxide is linked to acid precipitation.
   - Coal is non-renewable.
   - Strip mining of coal damages the environment.

10. Gravitational potential energy is stored in the reservoir.

11. The energy conversions when generating hydro-electricity are as follows:

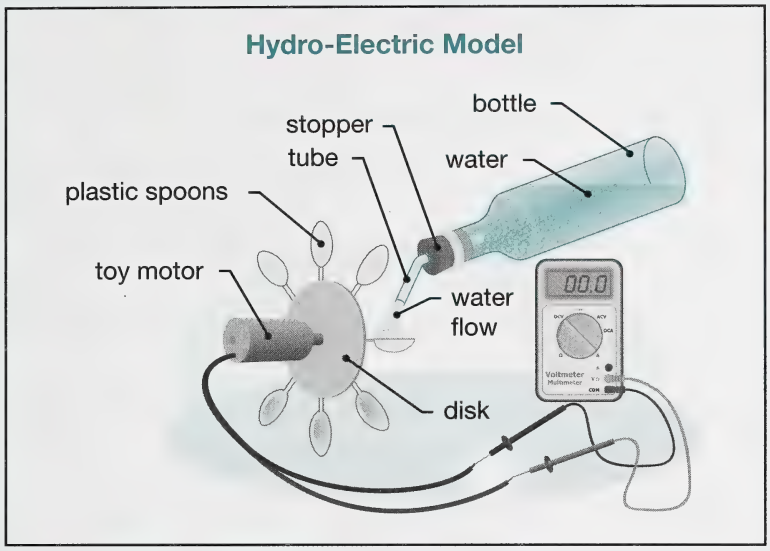
    - The gravitational potential energy of the water in the reservoir is converted into kinetic energy of falling water.

    - The kinetic energy of the falling water is converted into mechanical kinetic energy of the spinning turbines.

    - The mechanical kinetic energy of the spinning turbines is transferred to the generator, which converts it into electric energy.

12. The main disadvantage of hydro-electric power is that the generating stations require large dams. These dams produce large lakes or reservoirs that flood land, changing the ecology of the area.

13. Designs will vary. A sample design is given.



14. The energy conversions when generating electricity in nuclear power plants are as follows:

    - The potential energy in the nucleus of uranium atoms is converted into thermal energy (heat).
    - The thermal energy is converted into kinetic energy of the steam.
    - The kinetic energy of the steam is converted into mechanical kinetic energy of the spinning turbines.
    - The mechanical kinetic energy of the spinning turbines is transferred to the generator, which converts it into electric energy.

15. The main disadvantage of nuclear power is the difficulty of disposing spent fuel. Nuclear waste is dangerous to life for centuries. Also, the effects of an accident, if one should occur, can be serious.

16. The farther the light source is from the solar cell, the lower the voltage of the current it produces. Less light means less power generated.

17. To control other variables, reduce all other sources of light as much as possible.

18. Compare your observations to those given in Part B of the investigation.

19. The less light that falls on the solar cell, the less electricity produced. The farther the light source is from the solar cell, the lower the voltage produced.

20. **Textbook questions 1, 3, and 4 of "Check Your Understanding," p. 107**

    1. **step 1:** The potential chemical energy in the coal is converted into thermal energy.

       step 2: The thermal energy is converted into kinetic energy of steam.

       step 3: The kinetic energy of steam is converted into mechanical kinetic energy of the spinning turbines.

       step 4: The mechanical kinetic energy of the spinning turbines is transferred to the generator, which converts it into electric energy.

    3. A thermal-electric power plant and a thermonuclear power plant both use steam to drive the turbines.

    4. Only 90% of the electric energy leaving a power plant reaches consumers because 10% is converted into waste thermal energy in the transmission lines.

Section 2: Lesson 3

1. Energy is the ability to do work, and work is a force applied over a distance. Energy can be converted into work. Energy and work are equivalent and are measured using the same units.

2. Power is the rate of doing work. If work and energy are equivalent, then power is the rate at which energy is expended.

3. $60\ \text{W} = \frac{60\ \text{J}}{1\ \text{s}}$

   In 1 min, or 60 s, the bulb would use

   $$\frac{60\ \text{J}}{1\ \text{s}} \times 60\ \text{s} = 3600\ \text{J}$$

4. **step 1: Write down what you know.**

power = ?
energy = 210 J
time = 30 s

step 2: What do you want to find out?

how much power the light bulb uses

step 3: Use the formula.

$$\text{power} = \frac{\text{energy}}{\text{time}}$$
$$= \frac{210\ \text{J}}{30\ \text{s}}$$
$$= 7\ \text{J/s}$$

step 4: Express the power in watts.

The light bulb uses 7 W of power.

5. Write down what you know.

power = ?
energy = 2400 J
time = 1 min
= 60 s

Use the formula.

$$\text{power} = \frac{\text{energy}}{\text{time}}$$
$$= \frac{2400\ \text{J}}{60\ \text{s}}$$
$$= 40\ \text{J/s}$$

The speakers use 40 W of power.

6. Write down what you know.

$$\text{power} = ?$$
$$\text{energy} = 216\,000\ \text{J}$$
$$\text{time} = 1\ \text{h} \times \frac{60\ \text{min}}{1\ \text{h}} \times \frac{60\ \text{s}}{1\ \text{min}}$$
$$= 3600\ \text{s}$$

Use the formula.

$$\text{power} = \frac{\text{energy}}{\text{time}}$$
$$= \frac{216\,000\ \text{J}}{3600\ \text{s}}$$
$$= 60\ \text{J/s}$$

The light bulb uses 60 W of power.

7. **Textbook questions 1 and 2 of "Solve These," p. 109**

1. Write down what you know.

$$\text{energy} = ?$$
$$\text{power} = 100\ \text{W}$$
$$\text{time} = 1\ \text{h}$$

Use the formula.

$$\text{energy} = \text{power} \times \text{time}$$
$$= 100\ \text{W} \times 1\ \text{h}$$
$$= 100\ \text{W}\cdot\text{h}$$

The light bulb uses 100 W•h of energy.

2. Write down what you know.

$$\text{energy} = ?$$
$$\text{power} = 240\ \text{W}$$
$$\text{time} = 2\ \text{h}$$

Use the formula.

$$\begin{aligned}\text{energy} &= \text{power} \times \text{time} \\ &= 240\ \text{W} \times 2\ \text{h} \\ &= 480\ \text{W}\cdot\text{h}\end{aligned}$$

The light bulb uses 480 W•h of energy.

8. $$\begin{aligned}3.5\ \text{W}\cdot\text{h} &= 3.5\ \text{W}\cdot\text{h} \times 3600\ \text{J/W}\cdot\text{h} \\ &= 12\,600\ \text{J}\end{aligned}$$

There are 12 600 J in 3.5 W•h.

9. Using watt hours is more convenient because joules are very small units.

10. **Textbook questions 1 and 2 of "Solve These," p. 110**

1. Write down what you know.

$$\text{energy} = ?$$
$$\text{power} = 1000\ \text{W}$$
$$\text{time} = 3\ \text{h}$$

Use the formula.

$$\begin{aligned}\text{energy} &= \text{power} \times \text{time} \\ &= 1000\ \text{W} \times 3\ \text{h} \\ &= 3000\ \text{W}\cdot\text{h}\end{aligned}$$

Divide by 1000 to change W•h to kW•h.

$$\frac{3000\ \text{W}\cdot\text{h}}{1000} = 3\ \text{kW}\cdot\text{h}$$

The table saw uses 3 kW•h of electric energy.

2. Write down what you know.

$$\text{energy} = ?$$
$$\text{power} = 255\ \text{W}$$
$$\text{time} = 4\ \text{h}$$

Use the formula.

$$\text{energy} = \text{power} \times \text{time}$$
$$= 255\ \text{W} \times 4\ \text{h}$$
$$= 1020\ \text{W} \cdot \text{h}$$

Divide by 1000 to change W•h to kW•h.

$$\frac{1020\ \text{W} \cdot \text{h}}{1000} = 1.02\ \text{kW} \cdot \text{h}$$

The television uses 1.02 kW•h of electric energy.

11. There are 30 days in November. Convert the number of days to hours.

$$30\ \text{days} \times 24\ \text{h/day} = 720\ \text{h}$$

Find the total energy used to burn one light bulb continuously for the entire month of November.

$$\text{energy} = \text{power} \times \text{time}$$
$$= 100\ \text{W} \times 720\ \text{h}$$
$$= 72\,000\ \text{W} \cdot \text{h}$$

Multiply the total energy of burning 1 light bulb by 10 to determine the total energy of burning ten light bulbs continuously.

$$72\,000\ \text{W} \cdot \text{h} \times 10 = 720\,000\ \text{W} \cdot \text{h}$$

Divide by 1000 to change W•h to kW•h.

$$\frac{720\,000\ \text{W} \cdot \text{h}}{1000} = 720\ \text{kW} \cdot \text{h}$$

Annie is close in her estimate.

12. **Textbook questions 1, 2, and 3 of "Check Your Understanding," p. 110**

1. Watts are used to measure the power of electric appliances.
2. $\text{energy} = \text{power} \times \text{time}$

$= 1000\ \text{W} \times 1\ \text{h}$

$= 1000\ \text{W} \cdot \text{h}$

Divide by 1000 to change W•h to kW•h.

$$\frac{1000\ \text{W} \cdot \text{h}}{1000} = 1\ \text{kW} \cdot \text{h}$$

The hair dryer uses 1 kW•h of energy.

3. Power companies use kW•h rather than W•h because the kW•h is a larger unit and the consumption of power will be a more manageable number.

Section 2: Lesson 4

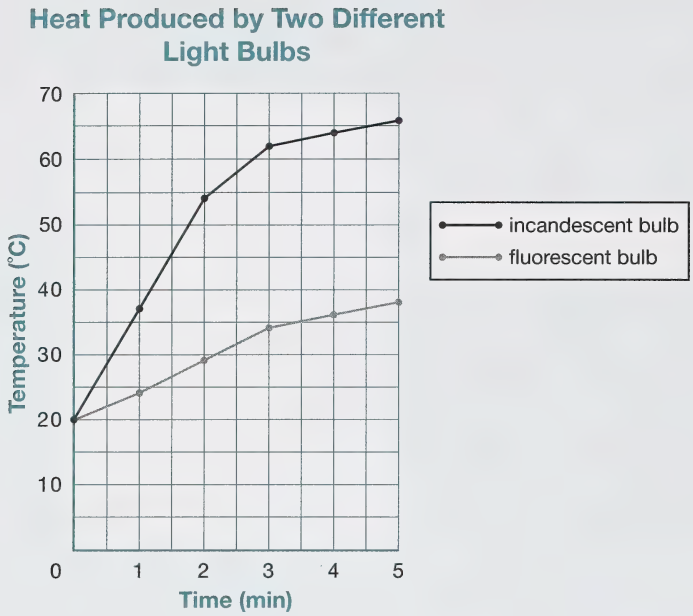
1. **Textbook question "Reading Check," p. 111**

The major form of waste energy in an incandescent light bulb is heat.

2. Answers will vary. Sample data is given.

Elapsed Time (min)	Temperature over Incandescent Bulb (°C)	Temperature over Fluorescent Bulb (°C)
0	20	20
1	37	24
2	54	29
3	62	34
4	64	36
5	66	38

3.



4. The two bulbs appeared to give off the same light intensity.

5. The incandescent bulb used more electric energy to produce heat because the temperature above this bulb rose faster.

6. **Textbook questions 1 and 2 of "Solve These," p. 112**

   1. Write down what you know.

      useful energy output = 900 J
      total electric energy input = 30 000 J
      efficiency = ?

      Use the formula.

$$\text{Percent efficiency of an electric device} = \frac{\text{useful energy output}}{\text{total electric energy input}} \times 100\%$$
$$= \frac{900\ \text{J}}{30\ 000\ \text{J}} \times 100\%$$
$$= 3\%$$

      The light bulb is 3% efficient.

2. Write down what you know.

useful energy output = 70 J
total electric energy input = 100 J
efficiency = ?

Use the formula.

$$\text{Percent efficiency of an electric device} = \frac{\text{useful energy output}}{\text{total electric energy output}} \times 100\%$$
$$= \frac{70\ \text{J}}{100\ \text{J}} \times 100\%$$
$$= 70\%$$

The motor is 70% efficient.

7. Answers will vary. Sample ways to conserve electric energy in the kitchen are as follows:

- When baking, do not preheat the oven more than necessary.
- When cooking on top of the stove, use a pot that is the same size as the burner.
- Don't leave the fridge door open too long. Decide what you want before you open the fridge door.
- Don't cook small items in the oven; use a toaster oven or microwave instead.
- Purchase appliances that are rated as energy savers.
- If nobody is in the kitchen, turn off the lights.

8. **Textbook questions 1, 2, and 3 of "Check Your Understanding," p. 113**

1. An incandescent bulb gets so much hotter than a fluorescent light bulb because it is not as efficient and it produces more waste heat.

2. Answers will vary. A sample answer is given.

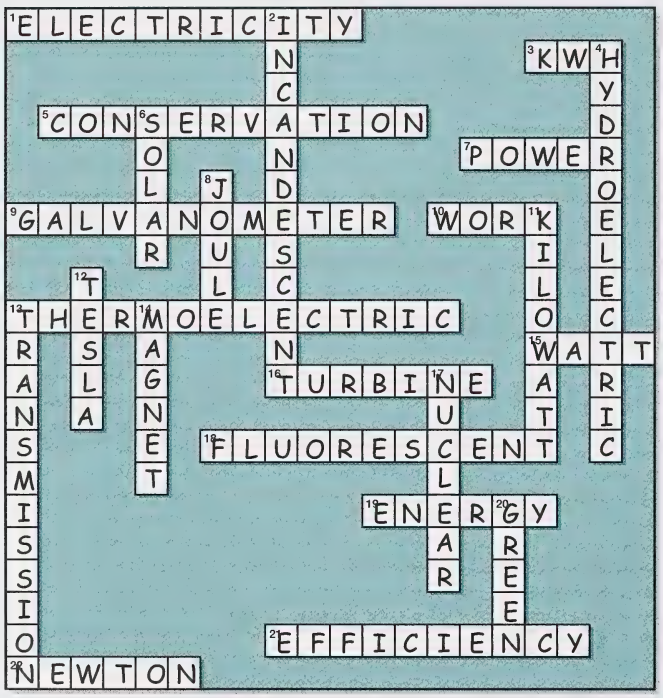
An electric appliance that is 60% efficient converts 60% of the input energy into useful output energy and 40% into waste energy (e.g., thermal energy, light energy, and sound energy).

3. Answers will vary. Three ways to conserve electric energy at home are as follows:

   - Turn off appliances, such as the television, stereo, or computer, when they are not being used.
   - Use fluorescent light bulbs rather than incandescent light bulbs.
   - Turn off lights if nobody is in the room.

Section 2 Review

1.



2. a. **Textbook question 1 of "Reviewing Key Terms," p. 114**

   1. a. ii b. vi c. iii d. i e. ix

      f. iv g. v h. vii i. viii

b. **Textbook questions 3, 4, 6, and 7 of "Understanding Key Ideas," p. 114**

3. Electricity is generated when a copper coil passes through a magnetic field.

4. Electricity in flowing water can be converted into electricity as follows:

   - The kinetic energy of the flowing water is converted into mechanical kinetic energy of the rotating turbines.
   - The mechanical kinetic energy of the rotating turbines is transferred to the generator.
   - The generator converts the mechanical kinetic energy into electric energy.

6. Answers will vary. Things you can do to conserve electric energy are as follows:

   - Use a timer on your vehicle heater cord in winter.
   - Open blinds and curtains during the day rather than turning on the lights.
   - Defrost freezers and refrigerators so they run more efficiently.
   - Use high-efficiency, fluorescent light bulbs.
   - Turn off the television when no one is watching.

7. Two reasons for reducing your use of electricity are to

   - protect the environment by reducing the need for additional power plants
   - help reduce the effects of carbon dioxide on the environment

c. **Textbook question 9 of "Developing Skills," pp. 114 and 115**

9. a. The incandescent light bulb releases more thermal energy (about two times more) than the fluorescent light bulb.

   b. The compact fluorescent bulb is more efficient (about two times more) because it releases less waste thermal energy than the incandescent light bulb.

d. **Textbook questions 10 to 13 of "Problem Solving/Applying," p. 115**

10. Divide by 1000 to change watts to kilowatts.

$$\frac{3000\ \text{W}}{1000} = 3\ \text{kW}$$

11. Write down what you know.

energy = ?
power = 100 W
time = 3 h

Use the formula.

$$\begin{aligned}\text{energy} &= \text{power} \times \text{time} \\ &= 100\ \text{W} \times 3\ \text{h} \\ &= 300\ \text{W}\cdot\text{h or } 0.3\ \text{kW}\cdot\text{h}\end{aligned}$$

You would use 300 W•h, or 0.3 kW•h, of electric energy.

12. $$\begin{aligned}\text{percent efficiency} &= \frac{\text{useful output energy}}{\text{input energy}} \times 100\% \\ &= \frac{190\ 000\ \text{J}}{240\ 000\ \text{J}} \times 100\% \\ &\doteq 79.2\%\end{aligned}$$

The kettle is about 79.2% efficient.

13. An electric appliance is 75% efficient if it converts 75% of the input energy into useful energy. This means 25% of the input energy is wasted.

e. **Textbook question 17 of "Critical Thinking," p. 115**

17. Conserving electric energy helps protect the environment from acid rain and global climate change by reducing the emission of sulfur dioxide, nitrous oxides, and carbon dioxide from thermal-electric plants.

Section 3: Lesson 1

1.

Colour	Test Tube			
	1	2	3	4
before heating	blue-green	blue-green	blue-green	blue-green
after heating	deep blue	red-orange	yellow-green	blue-green

Test tube 4 may be slightly yellow-green if not all the sugar was used by the yeast.

2. The yeast used the glucose for reproduction and growth. When 1 mL of yeast was added, not all the sugar was used up. When 2 mL of yeast was added, all or almost all of the sugar was used up. This was evident because the colour was blue-green after waiting 15 min and then heating the solution.

3. Test tube 1 and test tube 2 both act as a control. Test tube 1 shows that if there is no sugar, the Benedict's solution stays blue-green. Test tube 2 shows that the Benedict's solution turns red-orange when glucose is present.

4. Photosynthesis is a process in green plants that converts carbon dioxide and water into glucose and oxygen.

5. Photosynthesis occurs in cell parts called chloroplasts.

6. Chlorophyll is a green-coloured chemical that utilizes the energy of the Sun to assist photosynthesis.

7. a. The ingredients for photosynthesis are water from the soil, energy from the Sun, and carbon dioxide from the air.

   b. The products of photosynthesis are glucose and oxygen.

8. **Textbook question "Try This!," p. 118**

$$6\,CO_{2(g)} + 6\,H_2O_{(l)} \rightarrow C_6H_{12}O_{6(s)} + 6\,O_{2(g)}$$

Method 1

step 1: The letters C, O, and H are on the reactant side. C is the symbol for carbon. O is the symbol for oxygen. H is the symbol for hydrogen.

step 2: The coefficient 6 tells you that there are six CO_2 molecules. This means 6 C and 6 O_2.

$$6\,C = C + C + C + C + C + C$$
$$= 6 \text{ carbon atoms}$$

$$6\,O_2 = O_2 + O_2 + O_2 + O_2 + O_2 + O_2$$
$$= (O+O) + (O+O) + (O+O) + (O+O) + (O+O) + (O+O)$$
$$= 12 \text{ oxygen atoms}$$

The coefficient 6 tells you that there are six H_2O molecules. This means 6 H_2 and 6 O.

$$6\,H_2 = H_2 + H_2 + H_2 + H_2 + H_2 + H_2$$
$$= (H+H) + (H+H) + (H+H) + (H+H) + (H+H) + (H+H)$$
$$= 12 \text{ hydrogen atoms}$$

$$6\,O = O + O + O + O + O + O$$
$$= 6 \text{ oxygen atoms}$$

step 3: There is a C, H, and O on the product side.

step 4: First, look at $C_6H_{12}O_6$. The subscript 6 tells you there are six carbon atoms. The subscript 12 tells you there are 12 hydrogen atoms. The subscript 6 tells you there are six oxygen atoms.

Now, look at 6 O_2. The coefficient 6 tells you there are six O_2 molecules.

$$6\,O_2 = O_2 + O_2 + O_2 + O_2 + O_2 + O_2$$
$$= (O+O) + (O+O) + (O+O) + (O+O) + (O+O) + (O+O)$$
$$= 12 \text{ oxygen atoms}$$

step 5: reactant side = 6 atoms of carbon, 12 atoms of hydrogen, 18 atoms of oxygen
product side = 6 atoms of carbon, 12 atoms of hydrogen, 18 atoms of oxygen

Yes, the equation is balanced.

Method 2

$$\text{Reactants} = 6\,CO_2 + 6\,H_2O$$

$$= (CO_2 + CO_2 + CO_2 + CO_2 + CO_2 + CO_2) + (H_2O + H_2O + H_2O + H_2O + H_2O + H_2O)$$

$$= (C + O_2) + (C + O_2) + (C + O_2) + (C + O_2) + (C + O_2) + (C + O_2) + (H_2 + O) + (H_2 + O) + (H_2 + O) + (H_2 + O) + (H_2 + O) + (H_2 + O)$$

$$= C + (O + O) + C + (O + O) + C + (O + O) + C + (O + O) + C + (O + O) + C + (O + O) + (H + H) + O + (H + H) + O + (H + H) + O + (H + H) + O + (H + H) + O + (H + H) + O$$

$$= (C + C + C + C + C + C) + (O + O + O + O + O + O + O + O + O + O + O + O + O + O + O + O) + (H + H + H + H + H + H + H + H + H + H + H + H)$$

$$= 6 \text{ carbon atoms, } 18 \text{ oxygen atoms, } 12 \text{ hydrogen atoms}$$

$$\text{Products} = C_6H_{12}O_6 + 6\,O_2$$

$$= (C_6 + H_{12} + O_6) + (O_2 + O_2 + O_2 + O_2 + O_2 + O_2)$$

$$= (C + C + C + C + C + C) + (H + H + H + H + H + H + H + H + H + H + H + H) + (O + O + O + O + O + O) + (O + O) + (O + O) + (O + O) + (O + O) + (O + O) + (O + O)$$

$$= (C + C + C + C + C + C) + (H + H + H + H + H + H + H + H + H + H + H + H) + (O + O + O + O + O + O + O + O + O + O + O + O + O + O + O + O + O + O)$$

$$= 6 \text{ carbon atoms, } 12 \text{ hydrogen atoms, } 18 \text{ oxygen atoms}$$

The equation is balanced.

9. Cellular respiration occurs in the mitochondria of cells.

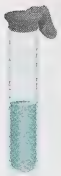
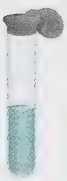
10. a. The reactants of cellular respiration are glucose and oxygen.

    b. The products of cellular respiration are carbon dioxide, water, and energy.

11. The equations for cellular respiration and photosynthesis are opposite reactions.

12. The converters in photosynthesis are the chloroplasts in the leaves of green plants. The converters in cellular respiration are the mitochondria in cells.

13.

Test Tube	Contents	Changes in the Test Tube	Sketch
1	• 5 mL yeast mixture	• Yeast does not appear to grow.	
2	• 5 mL yeast mixture •1 g sugar	• Yeast grows and increases in volume. • bubbling in test tube	
3	• 5 mL yeast mixture •1 g sugar • 25 drops vinegar solution	• Yeast does not grow much. • some bubbling	
4	• 5 mL yeast mixture •1 g sugar • 25 drops bleach solution	• Yeast does not appear to grow.	
5	• 5 mL yeast mixture •1 g sugar • 25 drops ammonia solution	• Yeast does not appear to grow.	
6	• 5 mL yeast mixture •1 g sugar • 25 drops fertilizer solution	• Yeast grows more rapidly than in test tube 2. • bubbling in test tube	

14. a. **Textbook questions 1 to 4 of "Analyze," p. 121**

1. Test tube 1, which only contained the yeast mixture, and test tube 2, which only contained yeast and sugar, served as controls for the investigation.

2. Test tube 6, which contained sugar and fertilizer, collected the most gas.

3. Test tubes 1, 4, and 5 collected the least amount of gas.

4. There was no yeast growth in test tube 1 because there was no sugar (nutrient). In test tube 2, the yeast multiplied using the sugar as an energy source. In test tube 3, there was little or no yeast growth because the vinegar inhibited cellular respiration. In test tube 4, there was no yeast growth because the bleach killed the yeast. In test tube 5, there was no yeast growth because the ammonia killed the yeast. In test tube 6, there was accelerated yeast growth because there was sugar as an energy source and fertilizer to enhance cellular respiration.

b. **Textbook questions 5, 7, 8, and 9 of "Conclude and Apply," p. 121**

5. Carbon dioxide, one of the products of cellular respiration, was collected in the balloons.

7. Sugar and fertilizer speed up the rate of respiration.

8. Lack of sugar, vinegar, bleach, and ammonia slow or stop respiration.

9. If you were mixing a solution that would speed up respiration, you would add sugar and fertilizer.

c. **Textbook question 10 of "Extend Your Knowledge," p. 121**

10. The gas captured in a balloon and released extinguished the glowing splint.

    If the gas is bubbled through limewater, the limewater turns milky. This is a good indication that the gas is carbon dioxide because carbon dioxide is the only gas that causes limewater to turn milky.

15. **Textbook question "Try This!," p. 121**

(c) sugar ➡ yeast ➡ bubbles or foaming (gas)

16. Vinegar helps preserve cucumber pickles by inhibiting the growth of yeasts and other organisms.

17. An ecological pyramid is a graphic showing that it takes many organisms at lower levels to support fewer and fewer organisms at higher levels.

18. Only about 10% of the energy is transferred from a lower lever to the next higher level.

19. The owl is a secondary consumer. The owl is two levels above the grain. Only 10% is transferred between levels.

$$\begin{aligned} 10\% \text{ of } 10\% &= 0.10 \times 0.10 \\ &= 0.01 \\ &= 1\% \end{aligned}$$

Therefore, only about 1% of the energy in the grain is available to the owl.

20. **Textbook questions 1 to 4 of "Check Your Understanding," p. 122**

    1. Animals capture energy from the Sun by eating green plants or eating animals that eat green plants.

    2. When a student eats a hamburger, the input energy is the stored food energy in the carbohydrates, fats, and proteins in the hamburger. The converter is the mitochondria of the student's cells. The output energies are heat and the growth of new body cells.

    3. Cellular respiration is the conversion of glucose into energy, water, and carbon dioxide in the mitochondria of cells. It is important for humans because people need energy to live and grow.

    4. As you go higher in an energy pyramid, less energy is available because 90% of the energy at each level is converted into heat and maintaining the organisms at that level. This leaves only 10% of the total energy available to organisms at the next level.

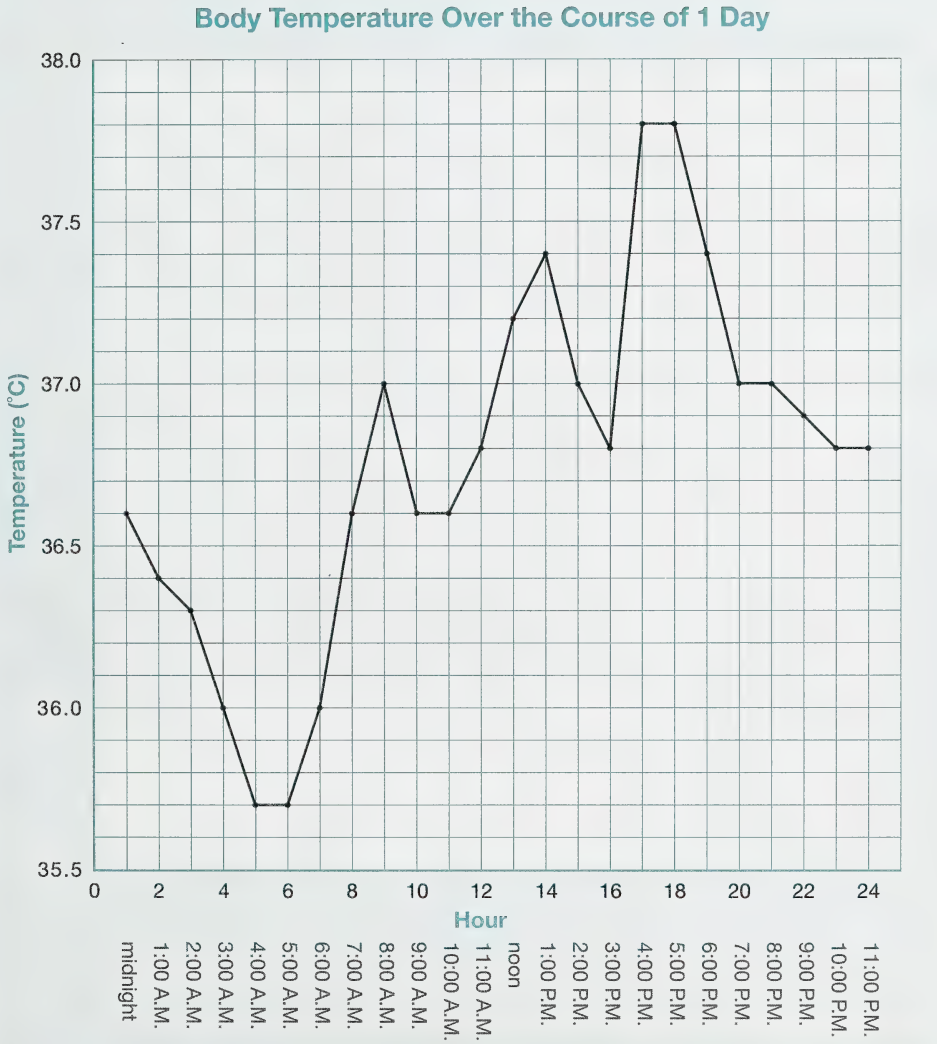
Section 3: Lesson 2

1. Homeostasis is the maintenance of a steady state. In regards to your body, homeostasis maintains your body's internal environment no matter what is happening outside your body.

2. To regulate your body temperature, your blood vessels dilate, thus transferring heat to the skin when you are too hot. Also, perspiration helps you cool down. To warm up, you shiver to convert more glucose into heat energy in your muscles. Also, your body can direct less blood to your limbs and more to your body's core.

3. A person with a high metabolism has high energy needs. This person may be able to eat a lot without gaining weight because the energy from the food he or she eats is used up or released.

4.



Note: The time of day given is for the answer to question 3.a. of "Analyze."

5. **Textbook questions 1, 2, and 3 of "Analyze," p. 124**

    1. The lowest body temperatures occur during hours 5 and 6. This is when the student is probably sleeping.

    2. This student is probably participating in a rigorous sport during hours 17 and 18 because, according to the graph, the student's body temperature is highest.

    3. a. Refer to the answer to question 4.

        b. During normal eating times, body temperature rises slightly because energy is being used to break down food during digestion.

6. **Textbook questions 1, 2, and 3 of "Check Your Understanding," p. 124**

    1. Metabolism is the rate at which energy is used in the body, and homeostasis is the steady state your body maintains. Your body temperature should not vary more than 1°C or 2°C. An abnormally high or low body temperature is a threat to your health. At extremes, it is life threatening.

    2. Four ways an organism, such as a cat, stays warm on cooler days are as follows:

        - It shivers. Quivering muscles produce heat.
        - It directs less blood to limbs and more blood to its body core.
        - It keeps physically active.
        - It stays in the sunlight and out of the wind.
        - It fluffs up its fur to increase the insulation value.

    3. By increasing physical activity, you increase your body's use of energy so calories stored in muscles and fat are burned. A physically active person can maintain a healthy weight more easily.

Section 3: Lesson 3

1. Health experts recommend that 55–65% of your energy needs should come from carbohydrates.

2. Glucose is the main source of energy for the human body.

3. Glucose that is not immediately needed is converted into a starch-like substance, called glycogen, which is stored in the liver and muscles.

4. "Carbo. loading" refers to eating a large quantity of carbohydrates a day or two before an athletic event. The carbohydrates are stored in the liver and muscles as glycogen and can be drawn upon to supply energy and enhance performance during the event.

5. People need body fat as a source of energy, to conserve energy, and for insulation against extreme temperatures.

6. The two groups of fat people consume are saturated fats (from animals and some oils) and unsaturated fats (mostly from vegetable oils).

7. A gram of fat contains a little less than twice the energy as a gram of carbohydrates.

8. The body will use protein as a source of energy when there is little fat or carbohydrates left.

9. The main sources of dietary protein are meat and vegetables, such as wheat and beans.

10. Extreme diets, such as severely limiting food, can lead to health problems in people of all ages and to developmental problems in children.

11. In foods like shredded wheat, there are other nutrients besides fats, carbohydrates, and proteins. There is water and dietary fibre just to name two.

12. Answers will vary. The results of a wafer bar, potato chips, and mixed nuts are given.

WAFER BAR

Source of Energy	16-g Serving (g)	Per 10 g (g)
carbohydrates	10	6.25
fat	4.3	2.69
protein	1.2	0.75

The grams of carbohydrates per 10 g was calculated as follows:

$$\frac{10}{16} \times 10 = 0.625 \times 10$$
$$= 6.25$$

The same formula can be used for fat and protein.

$$\text{Calories in } 10\text{ g} = (4 \times \text{carbohydrates}) + (9 \times \text{fat}) + (4 \times \text{protein})$$
$$= (4 \times 6.25) + (9 \times 2.69) + (4 \times 0.75)$$
$$= 25.00 + 24.21 + 3.00$$
$$= 52.21 \text{ kcal}$$

POTATO CHIPS

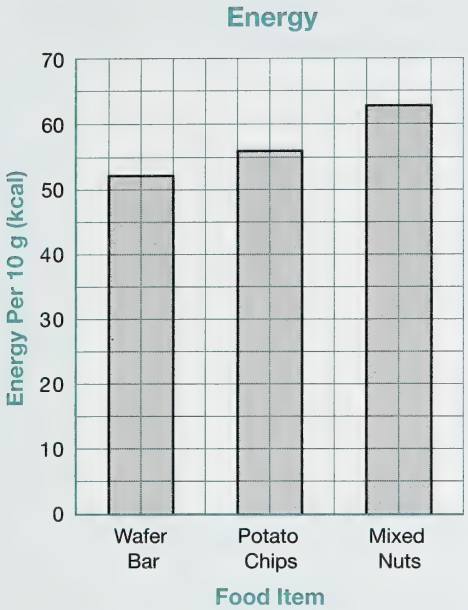
Source of Energy	28-g Serving (g)	Per 10 g (g)
carbohydrates	15	5.36
fat	10	3.57
protein	1.7	0.61

$$\text{Calories per 10 g} = (4 \times \text{carbohydrates}) + (9 \times \text{fat}) + (4 \times \text{protein})$$
$$= (4 \times 5.36) + (9 \times 3.57) + (4 \times 0.61)$$
$$= 21.44 + 32.13 + 2.44$$
$$= 56.01 \text{ kcal}$$

MIXED NUTS

Source of Energy	30-g Serving (g)	Per 10 g (g)
carbohydrates	5.7	1.90
fat	15	5.00
protein	7.8	2.60

$$\text{Calories per 10 g} = (4 \times \text{carbohydrates}) + (9 \times \text{fat}) + (4 \times \text{protein})$$
$$= (4 \times 1.90) + (9 \times 5.00) + (4 \times 2.60)$$
$$= 7.60 + 45.00 + 10.40$$
$$= 63.00 \text{ kcal}$$



13. Answers will vary depending on the snacks you chose. According to the information in the sample answer to question 12, mixed nuts contained the most energy per 10 g.

14. **Textbook questions 1 and 2 of "Check Your Understanding," p. 129**

    1. Carbohydrates are the first source of energy the body will use. To be more specific, the body will go to glucose, which is a simple carbohydrate.

    2. Answers will vary. Five foods high in carbohydrates are breads, pastas, rice, potatoes and yams, and fruits (e.g., apples and bananas).

Section 3: Lesson 4

1. A developing fetus gets nutrition from the mother through the umbilical cord.

2. Breast-fed babies are less likely to get sick because they obtain antibodies from their mothers in the breast milk.

3. Metabolic needs are energy needs.

4. During puberty, young people have high metabolic needs because they are growing in height and weight and maturing physically and sexually.

5. Mothers who are breast-feeding have a high metabolism because they are providing nutrients for themselves and the child (or children in some cases).

6. Factors that affect metabolism are age, time of day, exercise, and level of fitness.

7. To avoid gaining unnecessary weight, keep physically active and limit the amount you eat.

8. **Textbook questions 2, 3, and 4 of "Check Your Understanding," p. 131**

    2. The best food for babies is breast milk, which contains all the nutrients necessary for them to thrive. Babies have high nutrient and energy requirements because they are developing so quickly. Seniors should follow Canada's Food Guide for a balanced diet. However, their energy requirements are generally not as high as when they were younger, so they do not require the same quantities of food.

    3. Answers will vary. Some occupations you would expect workers to have high metabolisms are carpenters, oil-rig workers, trappers, and physical-fitness trainers.

    4. a. The construction worker's metabolism is likely to go down because a rural mail route involves using a vehicle to deliver the mail.

        b. The metabolism of mother who stops breast-feeding would go down because she is no longer providing the nutritional needs of the child.

        c. A gymnast who begins training would require more energy and, therefore, would have an increased metabolism.

        d. A weight lifter who takes time off training would have decreased energy needs and, therefore, a decreased metabolism.

Section 3 Review

1. **Textbook questions 1 to 5 of "Reviewing Key Terms," p. 132**

    1. Chloroplasts are the parts of the cells in green plants that contain chlorophyll. It is the part of green plants where photosynthesis occurs. Chlorophyll is a green-coloured chemical that assists in using the Sun's energy to combine water and carbon dioxide to produce glucose and oxygen.

2. Photosynthesis and cellular respiration involve the same compounds, but they are reverse reactions. Photosynthesis uses the Sun's energy to combine water and carbon dioxide to produce glucose and oxygen. Cellular respiration uses glucose and oxygen to produce energy, water, and carbon dioxide.

3. Saturated fats come from animal fats and some oils. Unsaturated fats come mostly from vegetable oils.

4. For energy, the body first goes to glucose, a simple carbohydrate; then it goes to other carbohydrates, fats, and proteins in that order.

5. Metabolism is the rate at which a body uses energy. Homeostasis is the mechanism that regulates metabolism and other processes to keep a body in a steady state.

2. **Textbook questions 6 to 11 of "Understanding Key Ideas," p. 132**

6. In the chloroplasts of the cells in green plants, chlorophyll, a green-coloured chemical, assists in capturing the Sun's energy and uses it to combine water and carbon dioxide to produce glucose and oxygen.

7. No, not all the energy produced by a plant is available to those that consume it. Some of the energy is waste heat, and some is used by the plant in respiration.

8. "Carbo. loading" refers to eating a large quantity of carbohydrates a day or two before an athletic event. The carbohydrates are stored in the liver as glycogen and can be drawn upon to supply energy and enhance performance during the event.

9. You should limit saturated fats to help prevent the onset of heart disease.

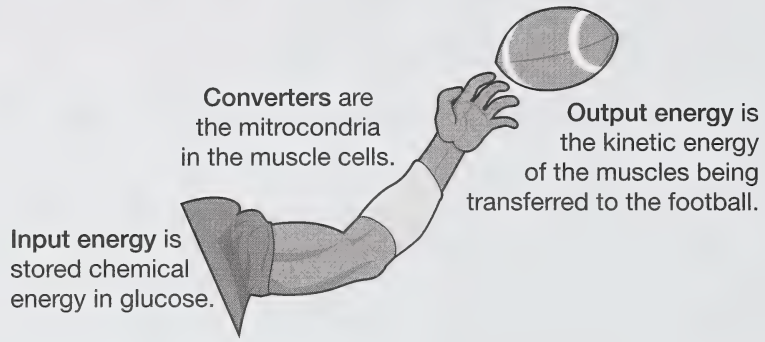
10. As you grow older, your energy needs decrease. As a child and adolescent, your needs are high as you grow and mature. Your needs level off as an adult, and decline as you approach your senior years and become less active.

11. The fetus receives nutrients from the mother through the umbilical cord.

3. **Textbook questions 13 and 14 of "Problem Solving/Applying," p. 132**

13. Your friend should eat large amounts of carbohydrates and proteins. The carbohydrates will provide the energy needed for weight lifting, and the protein will help build muscles. The amounts he or she eats should exceed his or her daily energy requirements during training.

14. Sketches may be similar to the following.


Converters are the mitrocondria in the muscle cells.
Output energy is the kinetic energy of the muscles being transferred to the football.
Input energy is stored chemical energy in glucose.

Some of the energy is not used for throwing the ball; it is lost as heat.

4. **Textbook question 16 of "Critical Thinking," p. 133**

16. If your friend is concerned about weight gain, she should eat breakfast just before school starts when her metabolism is high. If the body goes without food, the metabolism will slow down and make it more likely she will gain weight.

Section 4: Lesson 1

1. **Textbook question 1 of "What to Do," p. 135**

a. Answers will vary. In 2003, 1 L of recycled motor oil was approximately $0.80–$1.00/L. New motor oil was about $1.50–$2.50/L per litre, and synthetic motor oil was about $7.00/L.

b. Answers will vary. Depending on the brand, 1 L of bottled water was about $1.50.

c. Estimates will vary. The world is using more oil than 20 years ago. Scientists believe there is enough oil for approximately 30–50 years.

d. Even though Canada has the world's largest reserves of fresh water, all parts of Canada are facing supply shortages. Opinions about the export of Canada's fresh water will vary. Some feel Canada should sell water as a commodity; others feel Canada needs to conserve water for Canadians.

2. Some experts predict the demand for oil could outstrip supply within the next 10 years.

3. Fossil fuels are referred to as non-renewable resources because once they are consumed they are gone forever.

4. Coil, oil, and natural gas are called fossil fuels because, like fossils you can see in a rock millions of years old, they are the remains of living plants and animals that lived millions of years ago.

5. a. Three kinds of coal, from softest to hardest, are lignite, bituminous, and anthracite.

   b. The harder types of coal are formed by additional layers of sediment. The additional layers increase the pressure and temperature put on the layer of coal.

6. The main difference is that natural gas and oil were formed from marine plants and animals when the area was covered by a shallow sea. Coal was formed from land plants that grew at a time when areas were covered by swamps.

7. **Textbook question "Reading Check," p. 137**

   Coal was used in the following ways 100 years ago:

   - Coal-fired locomotives provided transportation for people and goods.
   - Coal-fired steam engines provided power for factories.
   - Coal-burning tractors helped with harvesting.
   - Coal-burning furnaces were used to heat homes and office buildings.

8. Petroleum is another name for crude oil.

9. First Nations peoples in southern Alberta used crude oil for healing.

Section 4: Lesson 2

1. **Textbook question "Reading Check," p. 128**

   Alberta's coal is used for the generation of electric energy and in the iron and steel industry.

2. Open-pit mines are the principal sources of western Canadian coal because

   - they are cheaper to extract than underground mines
   - much of the coal is near the surface

3. Open-pit mining strips away vegetation and topsoil to access the coal.

4. Open-pit mines reclaim the land by

    - taking an inventory of the original vegetation
    - stockpiling topsoil so it can be used later in reclamation
    - grading the land to form a contoured landscape while returning the original topsoil
    - planting the area with native grasses, plants, and trees

5. Oil in Alberta was first discovered near Turner Valley in 1914.

6. Impermeable rock is rock that gas, oil, and water cannot penetrate.

7. a. **Well A:** water
   Well B: oil
   Well C: oil
   Well D: natural gas
   Well E: nothing, drilling ended in impermeable rock, probably shale

   b. The porous rock layer is coloured blue, black, and red depending on what is present in that region of the porus rock.

8. The rock where natural gas, oil, and water is trapped is called reservoir rock.

9. Because water is more dense than oil and natural gas, it forms the bottom-most layer in reservoir rock.

10. **Textbook question "Reading Check," p. 140**

    Geologists use a seismic survey to locate potential oil and gas reserves. Shock waves from compressed-air guns, thumper trucks, or explosives are sent through the layers of Earth's crust. The sound waves reflected off these layers are analyzed by computers to create images of these layers. Geologists interpret these images to see if they show the likelihood of gas and oil formations.

11. The estimated reserves in the Athabasca Oil Sands are between 1.7 and 2.5 trillion barrels.

12. The land in the Athabasca Oil Sands area is a result of sand left by ancient rivers covered by a layer of clay. It is thought that oil from the southern part of the province migrated into these sands due to the same pressures that formed the Rocky Mountains.

13. The oil sands are mined from open pits where huge power shovels and trucks are used. In some areas, the oil is deep and requires onsite extraction.

14. Hot water is mixed with the sands, forming a slurry from which the bitumen or oil is skimmed.

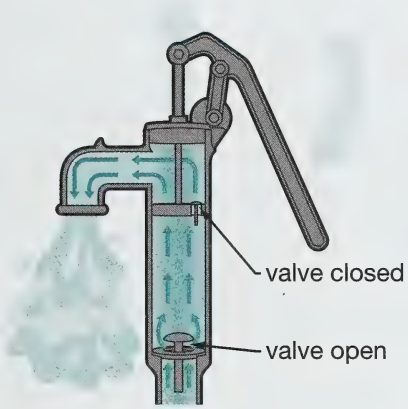
15. The water in a garden hose is like oil in reservoir rock. Before the nozzle on the hose is pressed, the water is under pressure. Similarly, before drilling into the reservoir rock, the oil is under a lot of pressure. Opening the nozzle on the water hose is like drilling into the rock. Just like water shooting out of the nozzle, the oil may shoot into the air before it is capped.

16. **Textbook question "Reading Check," p. 141**

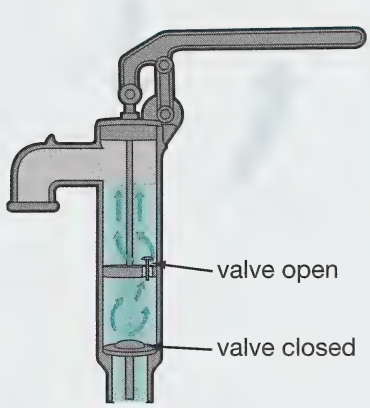
    A pump is used to bring oil to the surface when the pressure in the reservoir rock does not force the oil in the well pipe to the surface.

17. **Textbook questions 1 and 2 of "What Did You Find Out,?" p. 141**

    1. **Piston Upstroke**



    2. **Piston Downstroke**



18. Distillation is the process of separating various products from crude oil. The oil is heated. Different products with different boiling points are collected at various points in the refinery as the oil vapour cools and condenses. Heavy lubricants, such as motor oil and kerosene, condense first and are drawn off before lighter liquids, such as gasoline and naphtha.

19. **Textbook questions 1 to 5 of "What Did You Find Out?," p. 142**

    1. Cold water is used in the condenser to draw thermal energy from the steam and change it into a liquid.

    2. The distilled liquid was odourless and colourless. The soft drink has a cherry smell and is dark brown.

3. The temperature at which the liquid boiled was 100°C, the boiling point of water.

4. The liquid in the collection flask is water. Water is odourless, colourless, and boils at 100°C.

5. Crude oil could be boiled and cold water could circulate through the condensers to collect products with different boiling points from the vapours at different levels in the condenser.

20. The liquid in the glass is clear, and the soft drink is coloured. Also, the liquid in the glass does not have bubbles in it like the soft drink had initially.

21. Refer to the answers to question 19.

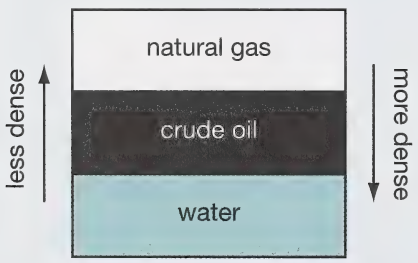
22. Pipelines are used to transport natural gas from gas wells to homes and industry.

23. Natural gas is a popular fuel because it supplies immediate heat when it burns and because it creates less pollution than oil or coal.

24. **Textbook questions 3, 4, and 5 of "Check Your Understanding," p. 143**

3. The various components of crude oil can be separated by the distillation process in refineries. Crude oil is vaporized using steam heat. The vapour is cooled at different levels in a fractional tower. The liquids are collected at different levels according to their boiling points.

4. Answers will vary. A sample answer is given.



5. Shock waves from compressed-air guns, thumper trucks, or explosives are sent through the layers of Earth's crust. The sound waves reflected off the layers are analyzed by computers to create images of these layers. Geologists interpret these images to see if they show the likelihood of gas and oil formations.

Section 4: Lesson 3

1. Combustion is the burning of a fuel in oxygen.

2. Fossil fuels are called hydrocarbons because they are compounds of hydrogen and carbon.

3. The reactants in a hydrocarbon combustion are the hydrocarbon itself and oxygen. The products in a hydrocarbon combustion are carbon dioxide gas and water.

4. It is dangerous to use an unvented propane heater indoors because, when combustion is not complete, carbon monoxide—a colourless, odourless, deadly gas—forms.

5. **Title:** Examining Combustion

   Problem: Demonstrate the following:

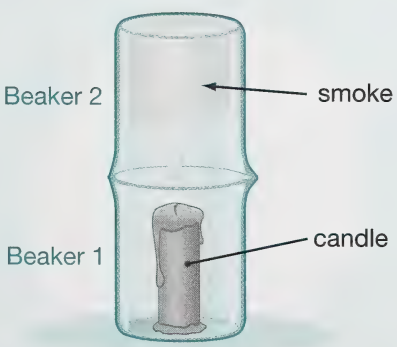
   - Oxygen is one of the reactants consumed in a combustion reaction.
   - A hydrocarbon (paraffin) is consumed in a combustion reaction.
   - Water vapour is produced in a combustion reaction.
   - The combustion reaction is exothermic (gives off heat energy).

   Materials and Apparatus:

   - 2 small, identical candles
   - 2, 250-mL beakers
   - ring stand
   - wire mesh
   - beaker tongs

   Diagram:

1.



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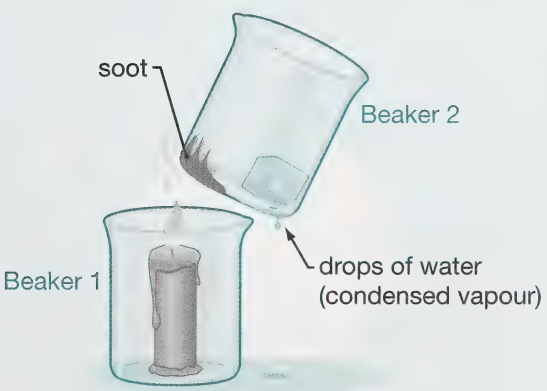

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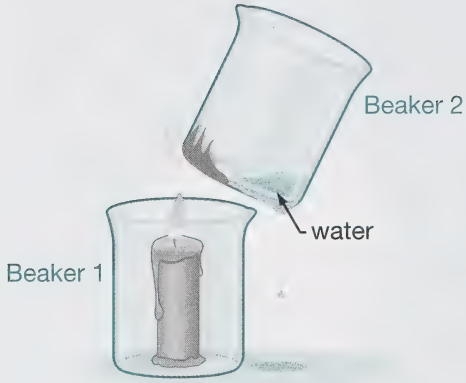

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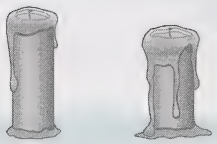


candle at start | candle at end

Procedure:

step 1: Place a small candle in one of the beakers, and place the beaker on the wire mesh on the ring stand.

step 2: Light the candle. Using tongs, place the second beaker upside down over the first beaker. Observe what happens to the candle flame after a short period of time.

step 3: Relight the candle. Put ice cubes in the second beaker and hold the second beaker with the tongs keeping the bottom about 10 cm above the flame. Observe what happens on the bottom of the second beaker. Also, observe what happens to the ice cubes in the beaker.

step 4: Blow out the candle and remove it from the first beaker. Compare the size of the candle to the second candle.

Observations:

step 2: When the second beaker was used to cover the beaker with the lit candle, the candle went out after a short period of time.

step 3: The bottom of the beaker showed droplets of water and some black soot on it. The ice cubes in the beaker started to melt after a short period of time.

step 4: The first candle was smaller in size compared to the unused candle.

Conclusion:

step 2: Something from the air was required to keep the candle burning. You can conclude that the required substance from the air is oxygen.

step 3: The droplets of water that formed on the bottom of the second beaker showed that moisture is coming from the flame. Therefore, water vapour is a product of combustion. The black soot that formed on the bottom of the second beaker showed that unburned carbon is coming out of the flame. The ice cubes melting in the second beaker showed that heat energy is given off by the flame.

step 4: The decrease in size of the candle showed that the hydrocarbon (paraffin) is consumed when the candle burns.

6. Glucose contains oxygen in addition to hydrogen and carbon.

7. **Textbook question 1, 2, and 3 of "Combustion and Cellular Respiration," p. 146**

   1. Glucose is the "fuel" burned in respiration. Methane is the fuel burned in combustion.

   2. Each source of energy reacts with oxygen gas.

   3. The products of each reaction is carbon dioxide, water, and energy.

8. **Textbook questions 1, 2, and 3 of "Check Your Understanding," p. 146**

   1. Technologies that use combustion to convert the energy stored in fossil fuels into different forms of energy are internal combustion engines, steam turbines, jet engines, refrigeration units, and home heaters to name a few.

   2. propane gas + oxygen gas → carbon dioxide gas + water vapour + energy

      $C_3H_{8(g)} + 5\,O_{2(g)} \rightarrow 3\,CO_{2(g)} + 4\,H_2O_{(g)}$ + energy

      input energy — **converter** — **output energy (burner)**

   3. a. Both combustion and cellular respiration produce carbon dioxide and water.

      b. In cellular respiration, glucose combines with oxygen. In hydrocarbon combustion, hydrocarbons combine with oxygen. Both reactions produce energy.

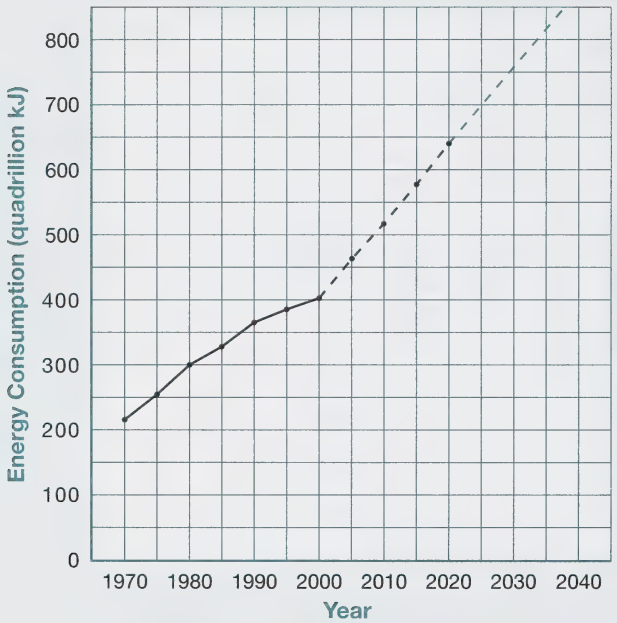
Section 4: Lesson 4

1. Fossil fuels are termed *non-renewable resources* because they are gone forever once they are used.

2. Two problems for marine life when an oil tanker runs aground are as follows:

   - Animals, birds, and fish ingest poisons from the oil spilled.
   - The covering of fur and feathers with oil removes natural insulation and waterproofing, so animals and birds die from exposure to the cold or drown.

3. **World Energy Consumption**



Note: The coloured, dotted line is for the answer to question 3 of "Analyze."

4. **Textbook questions 1 to 4 of "Analyze," p. 148**

   1. Year after year, the consumption of energy increases around the world.

   2. a. $2 \times 218 = 436$

      By the year 2000, energy consumption (406 quadrillion kJ) was almost double the energy consumption in 1970.

      b. It took about 30 years to double the energy.

3. Answers will vary. A sample answer is given.

   $2 \times 406 = 812$

   From the graph in the answer to question 3, it looks like energy consumption will double again around the year 2035.

4. To ensure fossil fuels will last longer, people can

   - increase their use of alternate energy sources like solar, nuclear, and wind power
   - conserve and recycle products made from fossil fuels
   - reduce energy use

5. The origin of acid deposition is the release of sulfur and nitrogen oxides into the atmosphere through the burning of fossil fuels. These oxides combine with water vapour in the air to produce acid fog, rain, and snow.

6. Acid deposition affects lakes and streams by raising their natural acidity to a point where fish and other organisms cannot reproduce.

7. The greenhouse effect is the trapping of thermal energy by the atmospheric gases.

8. Carbon dioxide, a greenhouse gas, is released into the atmosphere by the burning of fossil fuels. More thermal energy is trapped, which leads to global warming and global climate change.

9. Some of the evidence that supports concerns about global climate change include warmer winters; permafrost, glaciers, and polar ice caps melting at a faster rate; and precipitation decreasing in some areas and increasing in others.

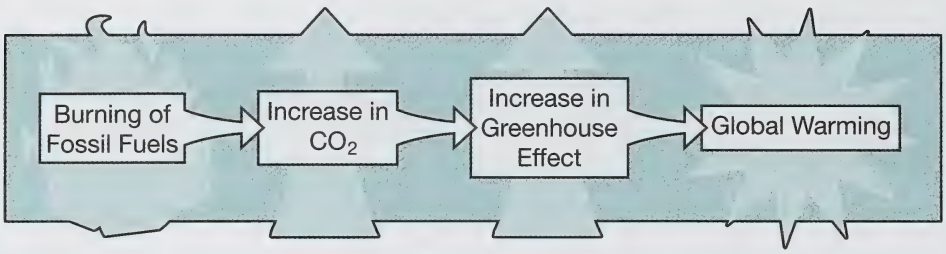
10. Things you and your family can do to help reduce greenhouse gases include

    - using energy-efficient appliances
    - reducing energy consumption (e.g., turning off lights when leaving a room)
    - increasing insulation in homes to reduce the consumption of oil and natural gas
    - buying fuel-efficient vehicles
    - taking public transportation or car pooling
    - buying electricity generated at wind, solar, or nuclear plants

11. **Textbook questions 1 and 2 of "Check Your Understanding," p. 149**

    1. Three risks are air pollution, environmental damage from strip mining and oil spills, and global climate change.

    2. Answers will vary. A sample answer is given.



Section 4 Review

1. **Textbook question 1 of "Reviewing Key Terms," p. 150**

    1. a. Coal, oil, and natural gas are examples of **fossil fuels**.

    b. **Natural gas** is a fossil fuel that can be found in the same rock formations as oil.

    c. **Coal** is a fossil fuel found in thick beds or seams.

    d. The process of **distillation** can be used to separate the components of a mixture.

    e. The **combustion** of fossil fuels is a common way to convert the energy in these compounds into other forms of energy.

    f. **Crude oil** is often found underground between a layer of water and natural gas.

    g. Because they consist of carbon and hydrogen, fossil fuels are called **hydrocarbons**.

    h. Once they are gone, they are gone. Fossil fuels are **non-renewable**.

    i. One reason to be concerned about burning fossil fuels is that this combustion may contribute to **global climate change**.

2. **Textbook questions 3, 4, and 6 of "Understanding Key Ideas," p. 150**

   3. Millions of years ago, Alberta was much warmer. Lush vegetation grew in swamps and on land. There was an inland sea where plants and marine animals thrived. These conditions led to the formation of fossil fuels.

   4. The coal industry was important to early European settlers in Alberta because it fuelled the steam locomotives and it helped heat their homes.

   6. Crude oil is considered to be a non-renewable source of energy because it takes millions of years to form. When present reserves are depleted, they are essentially gone forever.

3. **Textbook questions 9 and 10 of "Developing Skills," pp. 150 and 151**

   9. A Bunsen burner flame is an example of a combustion reaction because it releases heat, light, carbon dioxide, and water vapour.

   10. a. World energy consumption is increasing.

       b. Approximately 400 quadrillion kilojoules more energy will be used in 2020 than in 1970.

4. **Textbook questions 12 and 13 of "Problem Solving/Applying," p. 151**

   12. The chemical equation represents methane combustion.

   13. Comparisons of the combustion of propane with cellular respiration are as follows:

       - Oxygen is a reagent in both reactions.
       - Both reactions release energy.
       - The products of both reactions are carbon dioxide and water.

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Purpose: _____

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Materials and Apparatus:

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Diagram:

Procedure:

Observations:

Conclusion:

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